DEC 6 1909

TELEPHONE ENGINEER

Vol. II CHICAGO, AUGUST, 1909 No. 2

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6. One that can be installed without digging a hole.
7. One that screws into the solid ground without disturbing it.
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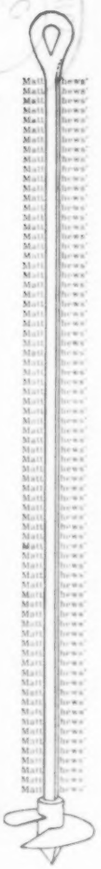

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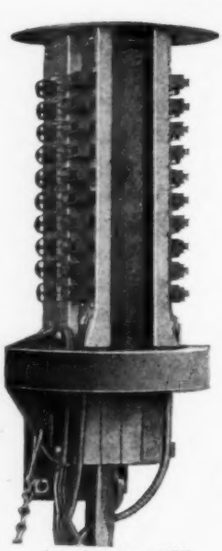

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TELEPHONE ENGINEER

VOL. II CHICAGO, AUGUST, 1909 NO. 2

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CHICAGO, AUGUST, 1909.

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SOMETHING DOING DOWN STAIRS.

THERE is a hurrying and scurrying among the officers and executive committee of the International Independent Telephone Association. One change in the acting personnel of the organization has already been made, and it is safe to predict that there will be at least one more change, very soon. There is an adjourned meeting, unfinished business and a shifting of operations from Chicago to Niagara Falls.

Now this is encouraging. It is almost refreshing, coming as it does just ahead of the torrid season. We feel sure that the outcome will mean something to the increased efficiency of the association as a working organization. There is need for a central bureau representing the enormous fabric of independent telephone development. A publicity department—a clearing house of informing data—a rendezvous for independent telephone operators. The organization should be the parent of state associations. The International conventions should have delegate representatives from subordinate bodies. The manufacturers, supply houses, allied trades and the press should be auxiliaries without a voice in convention deliberations. They could be heard, if called upon, but so far as further privileges go they should be given the icy glare, or something equivalent to that.

The retirement of H. D. Critchfield as the guiding spirit in the association is a matter of sincere regret. Mr. Critchfield has been long identified with telephone interests. He is loyal to the cause of independent telephony, adhering to the belief that two systems are irreconcilable. His arguments before the special committee of Chicago's city council were logical and it is generally conceded that he was instrumental in preventing certain negotiations that would have closed the door against competition. Mr. Critchfield's successor will find much to do.

There is vast opportunity for a working organization that will deal with the immense problems of independent telephone development and we are pleased to observe the present tendency to get busy.

SAN FRANCISCO.

THAT mythological bird which typified immortality by rising undestroyed from its funeral pyre has lost its potency in America. Habitually we out-phoenix the phoenix. We build upon our ashes not merely a dull replica of what has gone, but make calamity clear the way for a greater and grander structure than that which was destroyed. We seize upon the bare and smoking ground to build the edifices of our dreams, which previous occupancy has hindered.

San Francisco rebuilt is a greater and a better city than the San Francisco that was destroyed could have become in years of natural development. The lessons

of the years have borne fruit; and the opportunity to make correction was unequaled.

In the field of public utilities the telephone stands supreme. In tranquillity or in calamity our first need is speech with our fellows; and without the telephone our speech is limited indeed. So almost the first indication of industry in the stricken city, the advance guard of resumed activity, was the telephone engineers laying their plans for a greater system by the light of the burning buildings.

And San Francisco rebuilt has welcomed the telephone with outstretched arms. There is no talk there of the annoyance of a dual system. Practically all the new structures are wired for two systems.

For these reasons, and because San Francisco has one of the finest and largest independent telephone systems ever installed, the largest automatic installation ever completed, Telephone Engineer is proud to present the story of its inception and inauguration, told by the engineer who was responsible for its development. Samuel G. McMeen, by the successful undertaking of this great work, has added greatly to an engineering reputation already as broad as engineering itself.

The history of independent telephony on the Pacific coast is a record of development as clean and virile as any in the annals of the art. Within a few years from the inception of competition in Los Angeles, that community had the record for the number of telephones per unit of population. Whether this result was due to the unusual activity or efficiency of the operating company which accomplished the development, or to the attitude of the broad-gauged and optimistic people who inhabit the land of the sunset, we do not know. But the Home Telephone Company of San Francisco is the same company that operates in Los Angeles; and San Francisco, too, is on the sunset slope. The tokens point to a bright and busy future for the independent telephone plant of the Golden State metropolis.

HARVEST IN IOWA.

As far back as we can recall, harvesting of crops and sensational developments in the telephone industry come along about the same time. While the Iowa farmers are cutting their grain, the Iowa telephone operators are making some hay. The Corn Belt, Cedar Rapids and Marion, Johnson County and Hurmence systems have all been sold to the Iowa Telephone Company.

As usual, there is no reason given for this wholesale transferring of independent lines and exchanges to Bell ownership. The men who developed these extensive independent systems accepted a satisfactory consideration for their properties, pocketed the proceeds and have gone about their business. In some instances the services of the individuals who have long been identified with independent progress have been retained by the purchasers. So far as we can learn, James H. Shoemaker of the Corn Belt will continue to manage that property. H. A. Douglas of the Cedar Rapids and Marion system, has resigned his post to engage in business on his own account. S. S. Lichty will continue to edit his very personal page in the *Western Telephone Journal*, and we hope he will pull off an occasional interview with himself, for the first effort was a remarkable achievement. E. A. Hurmence sold every one of his exchanges and lines in Howard county and took over the Bell exchanges at Sumner and New Hampton. In addition, the Bell got West Union, Elgin and Clermont in Fayette county. Shade of Oscar Wentworth Rogers, what a blow to West Union! The arrangement has been to eliminate competition in a vast territory that has enjoyed intensive cultivation. How effectively it will accomplish this remains to be seen.

Presuming that the rates are to be slightly increased, the service still further improved, the long distance relations made more complete, then the probability of additional systems for that territory are somewhat obscure. The situation is interesting. We have good reason to believe that as between the two competing systems there must always exist an amicable relation. In examples like eastern Iowa now affords, there seems to be harmony in every camp. Independent capital has developed practically all the territory that the Bell formerly ignored. That capital has now been returned to the pioneers and the systems have been linked together. The men who fought for supremacy are still on the job rendering a service that will doubtless prove satisfactory while the thing is new. If the methods of the Bell assume the characteristics which prevailed prior to the advent of the independents, then there will be more territory for opposing plants.

There should be no wailing on the part of the independents over the Bell invasion of Iowa. The telephone census sets down more than 5,000 telephone organizations in the Hawkeye state alone, and the loss of a handful out of the northeast ought to strengthen the independent organization against further onslaught.

THE WRONG NUMBER.

In the mind of the telephone-using public there is a confirmed opinion that every wrong number connection is the fault of the operator. This is especially the view of the calling party. The subscriber whose bell is rung by error suffers equal annoyance; but his resentment is likely to be quite impartial. He blames the caller for not stating the number desired correctly or clearly, and then anathematizes "the service" for not giving the right connection, even when the wrong one was asked.

All this is inconsistent enough; but it is human nature, and has a bad effect upon the popular estimation of telephone service. The public will never make allowances for complicated apparatus and the consequent inevitable percentage of error. The fact that the human element in the work, as represented by the operator, makes occasional mistakes certain, does not interest the average subscriber. When shown how small the proportion of error actually is, he is all the more vexed that his particular station should encounter any of it. In short, the public demands absolute perfection, one hundred per cent efficiency, and no apology will answer as a substitute.

It is true that fifty per cent or more of the wrong number errors in a big telephone system are mistakes of the operator; and it is difficult to see how this percentage can be reduced. Perfection is impossible; and even this proportion of operating error represents a total error, based on the number of calls handled, of considerably less than one per cent—or an operating efficiency of over ninety-nine per cent. Great improvement can hardly be expected from this quarter.

It is obvious, then, that we must look to the agency responsible for the other fifty per cent of wrong number errors, namely the calling subscriber, for improvement in this feature of service. And the subscriber, being in no way responsible to the telephone company for the nature or way of his calling, is a difficult subject for improvement.

There are two sources of wrong number calls by the subscriber. The first is misinformation, by which the caller trusts to memory, to a faulty memorandum or record, or to a too hasty glance at the directory. The second source is indistinct enunciation, due either to personal carelessness or to speaking at too great a distance from the transmitter. Both are species of carelessness, and can be overcome to some extent by education.

Educating the public is a vague phrase and a tedious process. Educational publicity costs as much as commercial publicity; and advertising to reach a possible one-per-cent clientele is economically unprofitable. Appeals to the public inserted in the directory are inefficient because they usually occupy portions of the directory which do not come under the eye of the subscriber when he is hunting a number. The front of the transmitter affords a little space for a short appeal to the user; but its value is diminished by a condition quite the opposite of that which limits the directory. The transmitter front is so constantly before the eye of the user that he becomes immune to its import, and does not see it even while looking at it.

Probably the best—and simplest—cure for the careless subscriber is systematic supervision. It is not difficult to establish a record of those lines which are most subject to wrong number error; and a little study by the chief operator will determine the cause. The trouble thus run to earth, the careless individual ought not to prove a difficult subject for a course of tactful lectures on how to telephone. A few months of this supervision should effect a great improvement in the accuracy of service. And every careless user cured means that any number of other subscribers are partially relieved of the annoyance of answering wrong number calls.

RACINE GOES OVER.

THE Citizens' Telephone Company of Racine has been sold to the Wisconsin Telephone Company. The Citizens company was a prosperous institution—a fine example of independent development. It had forced its way into public favor, because it was owned by local investors, rendered splendid service and had the interests of the community constantly in mind. It had a third more patrons than its competitor and seemed to have things pretty much its own way all around, but it has been sold to the Bell.

The stockholders of the Citizens company received for their shares half cash and half stock in the Wisconsin company, the stock paying 6 per cent. They were also relieved from any liability in a bond issue of $125,000. Here are some of the conditions that prompted the stockholders to sell. The Citizens company has found it impossible to go the competitive pace, take care of extension demands, provide operating expenses, care for depreciation, and meet dividends. No dividends had been declared for the past two years. A mortgage of $125,000 had been placed upon the property to extend its usefulness as a public serving corporation.

A stockholder looks first to dividends. He is never a philanthropist. The money he puts into any enterprise is his investment. He invests his savings to make more money. Deny a stockholder his dividends, and then encumber his property with a bond issue and you are inviting trouble. The beauty of the investment pales. The lispings of the promoter or manager become turgid and the fairy tale that a better day is prospective goes into one ear and out of the other.

The telephone business must conserve the investor's money. The telephone industry is suffering temporarily, because too little care has been given this vital phase of the business. The promises have been too great; the rate too small; the reserve fund unprovided for; the hazards forgotten. Happily, independents are the first to recognize these short-comings. Amalgamations, mergers and corrections will bring order out of a condition that has been responsible for the loss of Racine.

THE FUNCTION OF THE ENGINEER.

A CORRESPONDENT whose letter is reproduced on another page rather takes TELEPHONE ENGINEER to task for not treating more generously and explicitly on the function of the telephone engineer in the development of telephony. He expresses the view that no development could take place, no organizers and builders achieve success in the art, but for the engineer; and that, in consequence, the engineer deserves further encomiums.

It appears to us that our correspondent's second premise is an answer to his first. We have always regarded engineering as fundamental, basic. The engineer represents the Atlas upon whose broad shoulders the whole superstructure is built and rests. He is responsible for the creation and efficient action of all other parts of the scheme of civilization.

So the function of the engineer is as broad as the art itself; and with the development of the art it is constantly growing broader. We cannot speak of the function of the engineer, in its present-day sense, as we can of the function of the accountant, or of the lawyer, or even of the architect. The modern engineer of greatest efficency must incorporate the attributes of all to some extent. The architect plans the edifice; but the engineer does more. His development study determines what and where the edifice shall be; his knowledge of equipment decides the selection of those parts which shall make the most efficient whole; his ability to read the future fixes the provision for development of both the actual project and its tributary agencies.

Appreciation of the engineer and his reward in worldly goods have never been as high as he deserved. But in this respect the last few years have shown a great improvement. It is now possible to point to more than one telephone engineer who is rapidly attaining a competence as well as the less tangible reward of reputation.

The function of the telephone engineer needs little definition, and certainly no defense.

SOME PROBLEMS OF TELEPHONY.

THE busiest telephone line is idle most of the time. Merely interesting in its application to local service, the fact becomes of considerable economical importance with the increase of long distance work. The traffic of a telegraph line is, by nature of its service, more evenly distributed than that of a telephone line; yet the telegraph was duplexed and quadruplexed long ago to meet the demands of economical transmission.

The design of a multiplex telephone system offers obstacles that seem, at present, almost insurmountable. The voice currents themselves cover such an extended range of power, frequency and direction, as apparently to preclude the possibility of either tuning, polarizing or sensitizing the circuit to transmit separate messages selectively.

In the local field the selective ringing system represents an attempt at increasing the efficiency of the line

by reducing its idle periods. But the advantage gained is almost nullified by the decrease in efficiency of service; the messages on a selective circuit inevitably overlapping and interfering.

The phantom circuit of long distance work is not usually classed as a selective system; but primarily its function is the same—to increase the efficiency of the line. The actual gain is represented by

$$N = 2n - 1,$$

where N is the greatest possible number of messages which can be sent simultaneously over n physical, metallic circuits. It can never become an actual duplex system. Obviously, conditions call for a greater saving than this.

Indications are that the problem will be met by some application to the line of the methods used in switchboard design. Fifteen switchboard cords, which are nothing but short trunk lines, will take care of one hundred busy telephone lines. It is plain, then, that with the proper apparatus, fifteen lines would do the present work of one hundred. And a curve constructed on this basis shows that the greater the number of lines, the greater the ratio and consequent efficiency.

THE CONTEST.

EARLY as it is, the contestants for that $50 prize, to say nothing of the $25, $15 and $10, are beginning to send in their solutions to the problem of making telephone subscribers good to each other. Some of them appear quite promising, too, although we have not had the opportunity to digest any of them thoroughly as yet. But it is our opinion that if they continue to come in at the rate promised by the present mail, the vital question of courtesy will be answered several times, and in another year the rampant telephone user will be quite tamed and civilized.

Remember that this is not a technical difficulty by any means. The only reason why telephone men might be better qualified to write on the subject than laymen is that they may be presumed to have spent more thought on it. But if you have a friend who has a civility theory, even if he does not know what a telephone exchange is, invite him to come in. We want all the improving thoughts on the subject we can gather. Their value to us is—well, the whole prize offer is reprinted on page 5, advertising section.

THE LAY IDEA OF WIRELESS.

IN a recent controversy as to the burying of wires in Sterling, Illinois, a "well-known telephone expert" was quoted by the local press to the effect that telephone companies hesitated to go to the expense of placing their wires in conduits because the wireless telephone might soon dispense altogether with that part of their equipment.

It is hardly conceivable that the general public, not to mention the telephone expert of the type quoted, hold so sanguine a view of immediate possibilities in wireless work. It is certain that reliable exponents of the ether wave make no assertions of the sort. But it is quite obvious that the situation contains possibilities for the misinformation of the credulous that are startling. The layman knows but one meaning for the word "telephone." To his mind this meaning is not altered by the prefix "wireless." The very sound of the combination seems to tell him that the difference is purely technical, and involves merely a change in plant.

We are all proud of the wireless telephone as a scientific achievement, as a laboratory experiment brought to commercial importance. As a rival to the common, garden variety of telephone, we know that in the ordinary phases of work it has no place. That fact can be kept before the public without detracting in any degree from the actual merit of the wireless in its own sphere of action.

BELL STOCKS.

THE American Telephone & Telegraph Company filed with the Philadelphia Stock Exchange, May 13, 1909, a list of the companies in which it holds stock. We regard the pile of dizzy figures of sufficient importance to all telephone men to give them a place right here:

Company—	Issued.	Owned by Am. T. & T. Co.
Bell Tel. Co. of Buffalo	$ 8,123,400	$ 4,376,200
Bell Tel. Co. of Missouri	8,788,000	5,831,800
Bell Tel. Co. of Pennsylvania	41,550,000	32,884,300
Cent. Dist. and Ptg. Tel. Co.	13,000,000	8,702,200
Cent. New York T. and T. Co.	961,500	660,300
Cent. Union Tel. Co.	5,450,927	4,315,590
Chicago Telephone Co.	27,000,000	14,049,600
Cin. and Subn. Bell T. Co.	7,058,050	2,118,000
Cleveland Telephone Co.	3,100,000	700,000
Colorado Telephone Co.	8,500,000	4,363,900
Cumberland Tel. and Teleg. Co.	19,680,150	10,508,400
Empire State T. and T. Co.	200,000	137,880
Hudson River Telephone Co.	3,909,900	2,033,100
Iowa Telephone Co., Preferred	932,450	932,225
Iowa Telephone Co., Common	1,263,625	321,770
Missouri and Kansas T. Co.	3,627,700	1,944,200
Nebraska Telephone Co.	4,584,300	3,330,616
New England T. and T. Co.	35,624,500	20,807,900
New York and Penn. T. and T. Co.	1,000,000	500,700
New York Telephone Co.	50,000,000	32,215,700
New York and New Jersey Tel. Co.	30,021,700	2,660,300
Northwestern Tel. Exch. Co.	6,000,000	1,074,800
Pacific T. and T. Co., Preferred	18,000,000	9,027,200
Pacific T. and T. Co., Common	18,000,000	9,027,200
Pioneer Tel. and Teleg. Co.	2,401,700	2,024,000
Providence Telephone Co.	3,000,000	900,000
Rocky Mt. Bell T. Co.	2,369,500	1,205,400
Southern Bell T. and T. Co.	21,400,000	21,394,300
Southern New England T. Co.	7,693,700	2,554,900
Southwestern T. and T. Co.	14,000,000	2,296,300
Wisconsin Telephone Co.	8,992,300	1,515,300
Diamond State Co.	5,000,000	3,221,600
Western Tel. and T. Co., Preferred	16,000,000	12,187,600
Western Tel. and T. Co., Common	16,000,000	9,143,500
Western Electric Co.	15,000,000	12,047,700
Bell Tel. Co. of Canada, Ltd.	12,500,000	4,822,400
Western Electric Tel. System	1,000,000	510,000

These figures are especially desirable to those who are watching the progress of the parent Bell in its present policy of absorbing its licensees. An offer has been made to the stockholders of the Bell Telephone Company of Pennsylvania to exchange eight of its shares for seven of A. T. & T. shares. A similar offer has been made to the New York & New Jersey Telephone Company.

It will be recalled that the Bell Telephone Company of Pennsylvania recently absorbed the old Chesapeake & Potomac Telephone Company, which covered Maryland, District of Columbia and part of Virginia; the Diamond State Telephone Company, which covered Delaware; and the Delaware & Atlantic Telephone Company, which operates in southern New Jersey.

The present offer contemplates a transfer of more than $36,000,000 of stocks, but it is only the beginning of what is apparently a general A. T. & T. plan to own outright all the present licensee companies. The corporation will probably increase its capital to a billion dollars—a cool sum to think about in hot weather.

San Francisco's Automatic System

By Samuel G. McMeen

SAN FRANCISCO stopped for a bit after the earthquake of 1906 and watched itself burning. Then the people rubbed their eyes and set about finding some sort of shelter, and under the encouragement of martial law, helped clear the streets.

San Francisco and Environs. The Towns and Cities in this Region Form One Community. The Home Telephone Company of Alameda County Is in Operation in Oakland and Emeryville, and the Plants in Surrounding Places are Being Constructed.

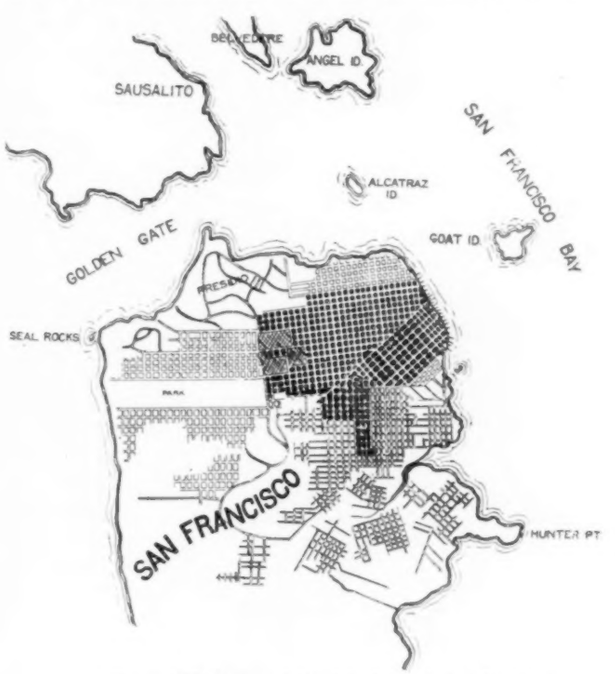
Very soon the "earthquake carpenters" were at work throwing together places for business. A part of these carpenters had used saws and hammers before. Then the bricklayers became active. Presently the minds of the people steadied enough to plan beyond the moment, and the tasks of architects, steel engineers and draftsmen began.

Structural steel could not be had in a moment, but the men and materials came in time. One of the very earliest of the new downtown office buildings was of reinforced concrete. The skyline changed suddenly, showing steel skeletons and boxlike molds for concrete. Pneumatic riveters began to drown out the sounds of saws and hammers.

The real community of San Francisco includes much more than the mere patch marked "San Francisco" on a map. San Francisco Bay shuts off Oakland, Berkeley and Alameda from the real city no more than the river shuts off Brooklyn from New York. A larger proportion of San Francisco's business population goes to the mainland to sleep than the portion of New York which sleeps in Brooklyn and Jersey City.

When the earthquake came, a good many people left San Francisco hurriedly. In effect, most of these merely moved to another part of the community by crossing the bay in some direction. With the renewal of business activities, these people recommenced their daily occupations in San Francisco proper, whether or not they reëstablished homes on the peninsula.

Broadly speaking, the population of San Francisco proper is only a little greater than at the time of the fire. The population of the entire community, however,



General Underground Conduit Area of San Francisco.

is much greater than at that time. At a rough figure, the population of the community is about 700,000. The effect on the business life of the city is much the same as if the North, West and South Sides of Chicago were suddenly to increase in population without a change in the intense business center. The effect is even more marked than a similar proportional change in the sizes of Brooklyn and towns on the Jersey side, for the reason that San Francisco is more absolutely the business center of its community.

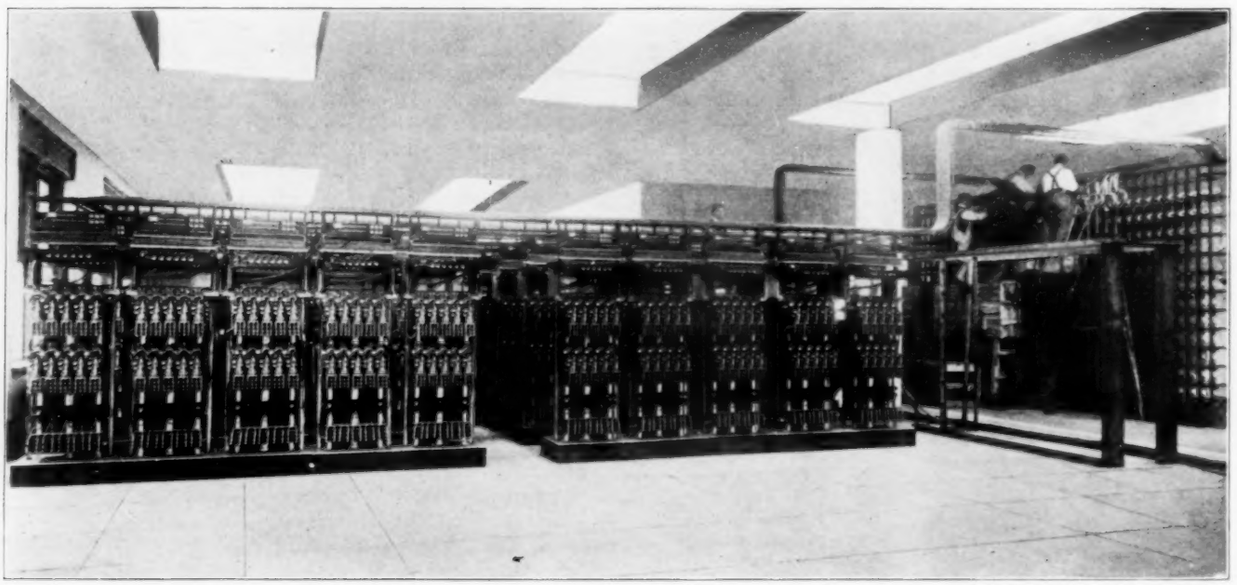
For nearly a year following the fire, the business of the city was housed in temporary quarters at the outskirts of the burned district. Now, three years later, practically all of the interests which were burned out downtown have returned to permanent downtown quarters. New buildings, however, are under way on every hand.

The progress that has been made toward the reconstruction of the city since the disastrous fire and earthquake of 1906 has never been equaled in history. The city today has a greater population than it had prior to the fire. Its prominence as a converging point for transportation, both land and marine, and its consequent preeminence on the coast as a commercial point have naturally constituted a dominant factor in the rebuilding of the city, inasmuch as the recognition of this has inspired the courage which has promoted the heroic and unprecedented work done during the past three years towards repairing the damage of April, 1906. San Francisco is already a bigger and better city than it ever was before, and is rapidly approaching the stage when every portion of the burned area will be covered with the most modern buildings known to present architecture. Nearly all of the new buildings are of a class calculated to withstand the effects of any repetition of the holocaust of three years ago. The office buildings of the entire business section of this city, which are all new, have been equipped for a dual telephone system, which very materially facilitates the progress of the home company's installation work.

The first region to restore itself after the fire was the mixed residence and business Latin Quarter. By means of their own, these citizens were able to produce the actual cash required for reconstruction in a shorter time than seemed possible in other parts.

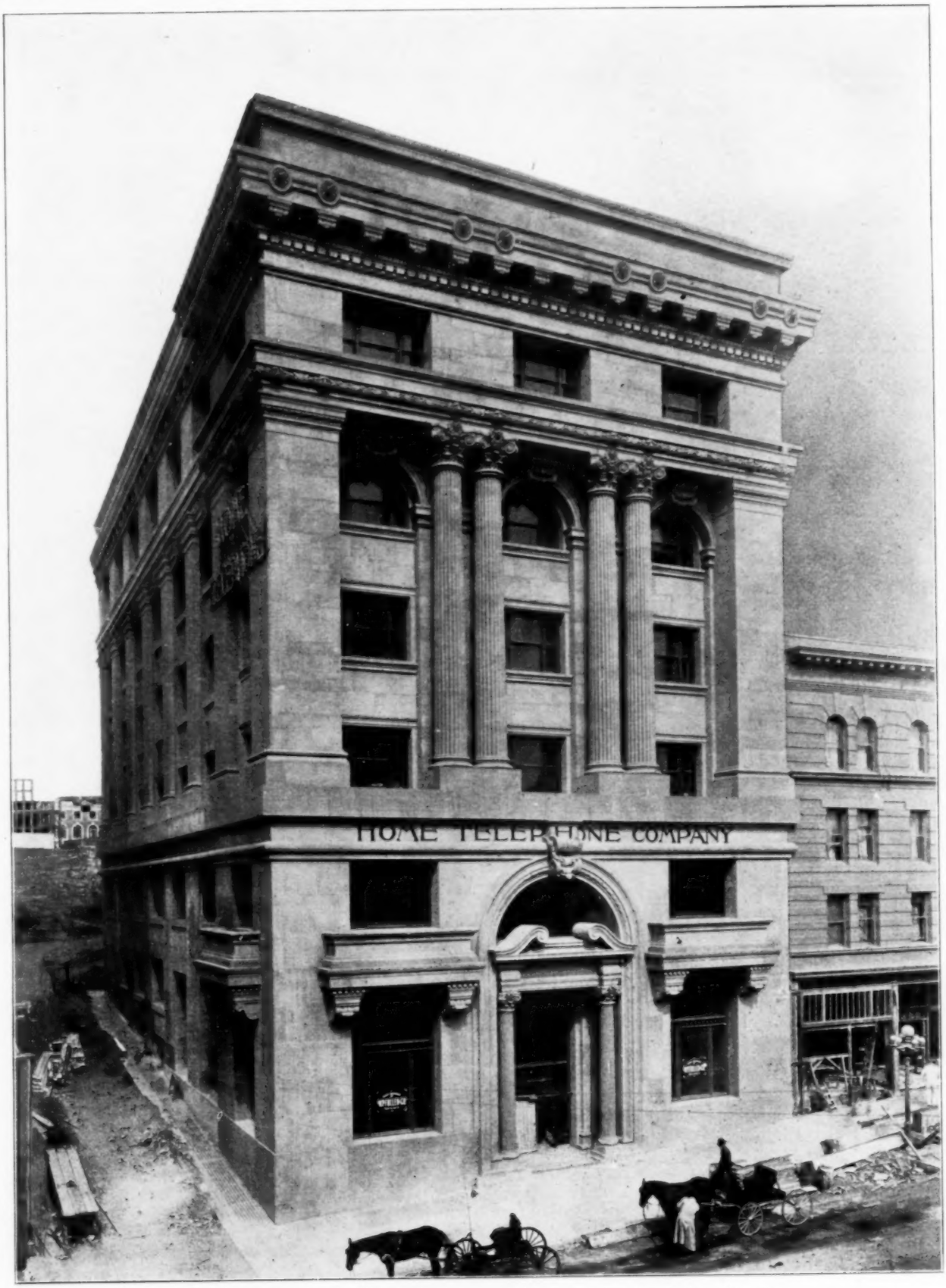
One of the show features of the old San Francisco was Chinatown, to which the tourist was guided with pride and from which he carried an assortment of curios and misinformation. In the summer after the fire, eastern newspapers persistently reported that the Chinatown district was to be changed to some outlying quarter. This has not happened. Chinatown is restored in its old location in a very attractive form and with all of its more respectable features improved. The intricate system of underground passageways, of which Chinatown guides have made so much in the past, probably has been eliminated by earthquake and reconstruction. At any rate, the Chinatown of today is, to all appearance, a respectable, busy and useful part of the new San Francisco.

Independent telephony reached California as a consequence of its original success in the middle west. The first important independent movement on the Pacific coast was in Los Angeles, beginning there seven years ago. It was Los Angeles which reached the maximum total telephone development of the world, outdoing Stockholm, Sweden, which had been the banner community until that time.



Main Switchboard Room, Central Office.

The Home Telephone and Telegraph Company of Los Angeles adopted the usual manual telephone switchboard for the first central office, but before the second central office was equipped a full investigation by the company's representatives had interested them in the automatic telephone. The interested parties thereupon secured the exclusive rights for the use of the automatic telephone in the state of California and the balance of the Los Angeles plant was made automatic. Its growth was unusual, if not unprecedented, and from a modest beginning of five thousand telephones it has grown, in a very few years, to a system of over thirty-one thousand with constantly increasing popularity; so much so, that the Home Telephone Company of Los Angeles now does



Grant Avenue Central Office, Near Sutter Street. Serves the Retail, Financial and Office District.

by far the greater portion of the telephone business of that city.

One consequence of the Los Angeles development was the development of Southern California in general, and another was the securing of a franchise in San Francisco. Pasadena was built and installed with long-dis-

Howard Office, Howard Street Near Fifth Street. Serves Downtown District, South of Market Street.

tance lines connecting the plant with Los Angeles. Santa Barbara followed, and one by one all of the important cities and towns south of the Tehachapi line now have independent telephone plants, each one of which is connected with Los Angeles by long-distance lines.

The physical and financial success which attended the independent movement in the southern end of the state logically gave rise to the extension of the movement to the northern portion of California; and with that object in view, the gentlemen identified with the initial independent plants in Los Angeles and elsewhere, applied for and secured by purchase a franchise from the city and county of San Francisco for the construction and installation of a plant in that city, the plan being to build and equip similar plants in all of the near-by Bay cities, viz: Oakland, Berkeley, Alameda, Fruitvale, etc.

Negotiations for the San Francisco franchise began before the fire and were brought to a formal completion immediately after it. No one who has not seen the city in ruins can form a clear appreciation of the courage and far-sightedness required to commit a group of interests positively to the construction of a telephone system in a city with so vague a future.

The ruins of San Francisco offered a unique opportunity for a telephone development study. One needed to determine at the outset what would be, at successive future times, the boundaries of retail shopping districts, the financial district, the wholesale and manufacturing districts and the several kinds of residence districts. It was entirely obvious that radical differences would exist between the old city and the new. Undisturbed, the causes of change would have shifted the boundaries of these general areas imperceptibly, but surely. A great catastrophe could make many of these changes come about at one jump, both by relieving the natural resistance to causes of change and by permitting the future to be anticipated.

How far and in what directions these influences might act were questions needing to be answered, and in them lay much of the difficulty and much of the absorbing interest of the task.

After the conception of the general picture of the future had been reached, the development study was conducted in the usual way, forecasting the possibilities of small unit areas and solving the whole for an economic arrangement of central office districts. Automatic equipment having been adopted considerably in advance of even the first general study, the detail development study contained one feature not usual in similar studies of earlier times. This was the changing conditions of automatic practice relative to a probable increasing economy in the use of inter-office trunk lines, with the further apparent probability of being able ultimately to subdivide the areas of less dense central office districts into sub-office districts containing satellite equipments.

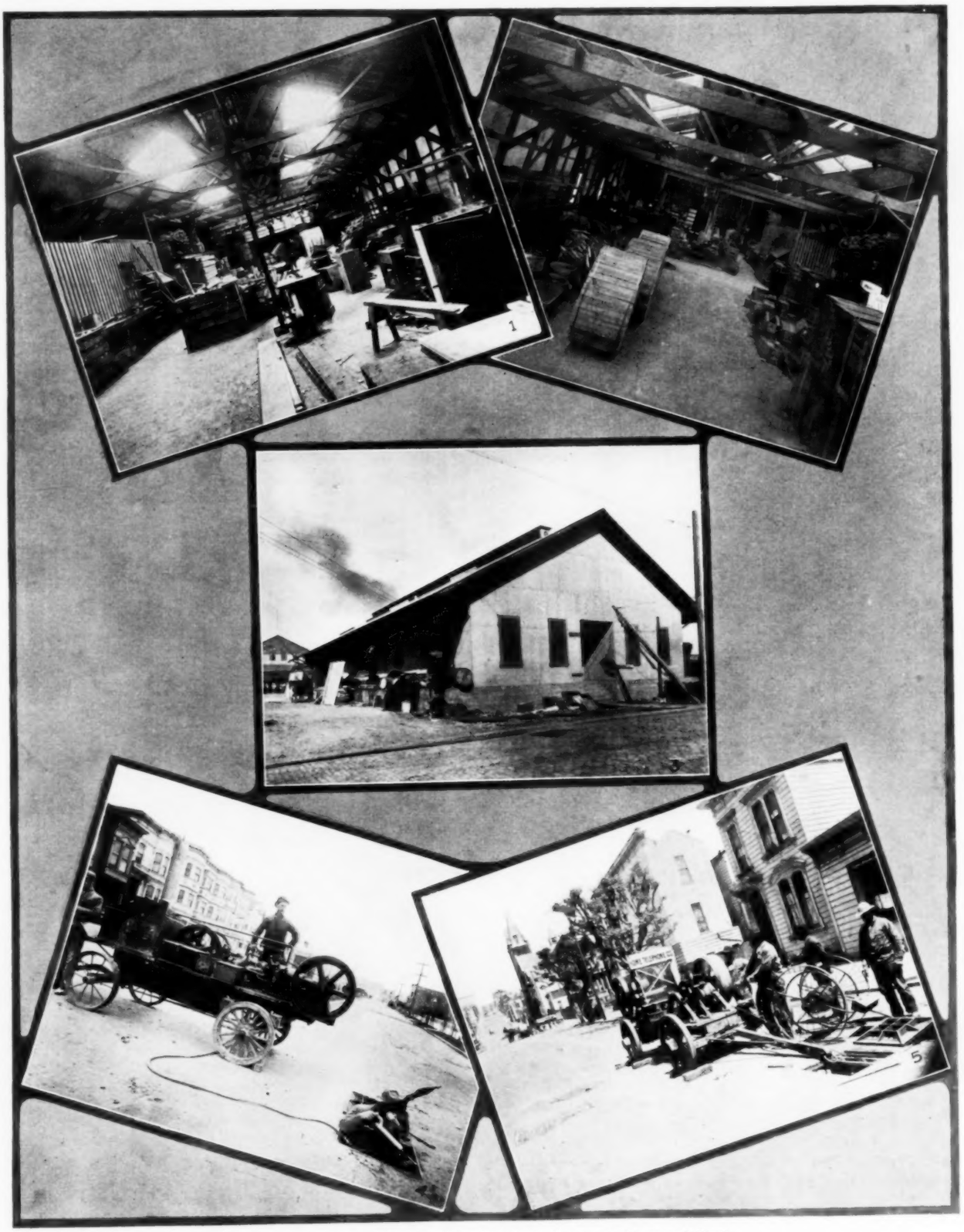
Local ordinances of San Francisco prescribe a downtown area in which the use of aerial wires is prohibited. The underground area actually adopted in the construction here described is many times larger than that legally named and is believed to be great enough to discount all future legislation within the period for which the original construction has been made. As executed so far, the conduit system now includes 421 miles of duct and 850 vaults. The area covered, considered in terms of highway, contains 160 miles of streets. The ducts are laid not more than four wide throughout, with a few unimportant exceptions.

The character of the underground construction is briefly that of surrounding all duct material with a concrete envelope, whatever may be the type of conduit employed. Both clay and bitumenized wood fiber duct materials are used. All vaults are of concrete, with reinforced tops. Conduit laterals are of iron pipe to a considerable degree. As water in the ground never freezes in San Francisco, a trapping of water in such a pipe is

West Office. Serves General Western Business and Residence Districts.

not a matter of great concern. The absence of freezing temperatures simplifies other features, particularly actual outdoor construction work, which is possible at all seasons.

A feature not often encountered is that in the low land near San Francisco Bay there are many vaults in



Some Views of the San Francisco Home Telephone Company's Shops and Work.

1—View of the Shop. 2—Interior of the Warehouse. 3—Warehouse, Shop and Storage Yard, Francisco and Montgomery Streets. 4—Drilling for Cable Supports by Means of Compressed Air. 5—Drawing Under-ground Cable at Vault in the Distance.

which the ducts are low enough to be below tide level. If such a vault have a sewer connection without some automatic trap, the tides will be found rising and falling in the vault with characteristic regularity. A sewer connection without an automatic trap, therefore, is a much poorer arrangement than no sewer connection at all. Even if there be none, the fact that the sand surrounding the vault is practically saturated the most of the time will keep water in the vault regularly.

Buildings in the intense business center naturally are served direct by cables from the conduit system. Back wall and fence distribution also are widely used. In such parts of the city as have alleys, distributing poles in them enable the distribution to be made by contact with the conduit system at the end of the alley. The conduit system lies at right angles to the alleys in all such regions.

The distributing system is entirely destitute of bare wire. Aerial terminals are of the porcelain type in which the seal between free air and the dry paper cable core is made by filling the terminal after the paper insulated

South Office, Seventeenth Street and Albion Avenue. Serves Mission and Potrero Districts.

wires are in position in the lock-nut binding posts. Throughout the distributing system, the principle of fusing each conductor at the point of junction between exposed and unexposed wiring is adhered to. At such points of junction, the fuses are housed in a manner suitable to the number of fuses, and where the circumstances require it, convenient means of taking off drop wires are provided for at least a part of the pairs which are fused.

There is an impression that the climate of California is an arid one. So far as San Francisco is concerned, the climate is not arid enough to make conductor insulation a simple matter. Rain falls rather steadily during four months in the year, and in many of the other eight, heavy fogs are swept over the city by the persistent trade winds. Out-door conductor equipment of certain types generally satisfactory elsewhere are unsuited to the San Francisco climate and have been excluded from the construction here described.

The requirements of the immediate future are met by housing the equipment and centering the trunk and subscribers' lines in four main offices. These will be supplemented by others from time to time, the establishment of each new center being accomplished by a predetermined rearrangement of distribution. All of the buildings are of fireproof construction. One of them is adapted to provide office quarters as well as to provide telephone switching equipment. All of the others are designed solely for switching purposes and may be said to possess unity in the sense that the attempt is to house the equipment by means of the building rather than to fill the building by means of the equipment.

All doors and windows having reasonable fire exposure are glazed with wire glass. Particular attention has been given to an even distribution of natural light, and it is believed that good fortune in location and some thought in design have furnished operating rooms of more than usual evenness and volume of daylight.

Each such building is designed large enough to accommodate the apparatus and machinery required for the switching of all of the lines of its district at the end of the long period used as the basis of the plans. This terminal and switching apparatus, power machinery, storage battery and other switching equipment is in part installed of its ultimate size at the beginning; other parts, like the cables in the underground conduits, are arranged in advance for convenient addition in units as the growth in subscribers shall require.

The scope of the plans is such as to enable 125,000 subscribers to be served without any change in the fundamental design and by means merely of addition in equipment and lines, as the subscription for telephone service shall increase.

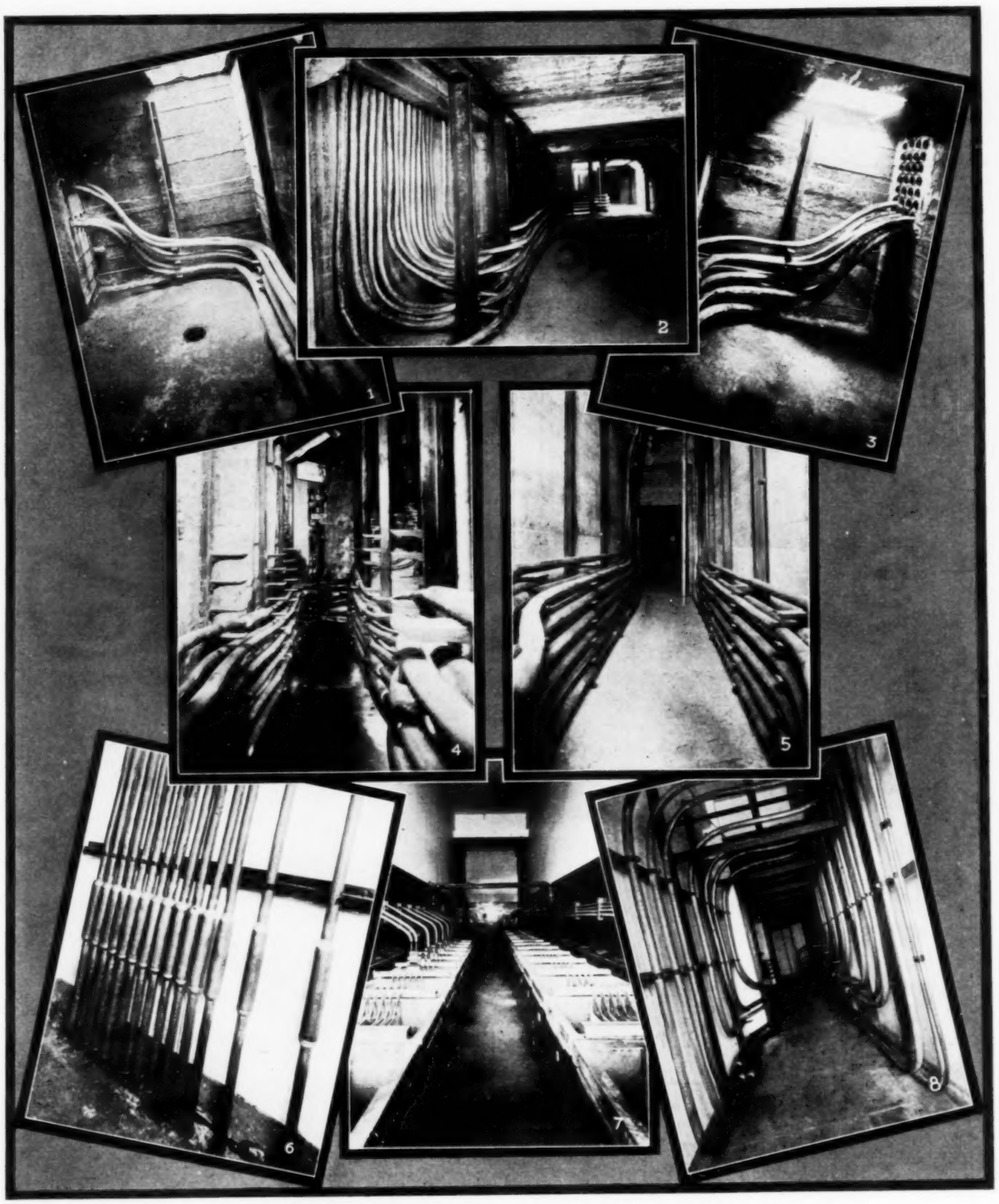
It also takes into account the present and future requirements of telephone traffic between San Francisco and suburban points. A considerable volume of business is transacted daily between San Francisco and Oakland, Berkeley, Alameda, San Rafael, Sausalito and other towns and cities in neighboring counties about San Francisco Bay. A large part of the business population of San Francisco has residence in these suburban places, passing to and from San Francisco daily. For these reasons there is a large and growing demand for telephone service between San Francisco and these suburban points.

The general design of the San Francisco telephone system contemplates reaching these suburban points over special trunk lines with the greatest economic speed and with a high grade of voice transmission.

The equipment is throughout of the automatic two-wire type, in which the connection is set up by means of rapid interruptions of the line at the subscriber's telephone. The ringing of the called subscriber is accomplished without the need of a special action on the part of the calling subscriber, as short periods of ringing succeed each other until the called subscriber answers.

The local ordinances of San Francisco relative to telephone rates do not permit the furnishing of flat rate business or professional service. The new equipment accordingly is provided with a complete system of service meters, one of which may be permanently connected to a subscriber's line, if needed. The record of the meter is in plain Arabic figures and a count upon it is made only when a called subscriber answers. If the call be for an official of the telephone company, for a recording operator with reference to long-distance or suburban connection, or if in any other way it is of a class for which the management wishes to make no charge, the meter finds itself unable to operate. The entire meter system operates automatically and with the need neither of special acts on the part of the subscriber nor a very general rearrangement of the circuits and apparatus standard for flat rate uses.

The San Francisco region is one requiring an extensive provision of "short-haul" toll line facilities. Sub-



Views Showing Details of Cabling and Storage Battery Plant, Home Telephone Company of San Francisco.

1—Forty-eight Hundred Wires Entering a Building. 2—Cables passing from Conduit Terminus to Vertical Cable Shaft, Grant Avenue Central Office. Each Cable Contains Eight Hundred Wires. 3—Concrete Manhole, Partly Equipped with Cables. 4—Cables Passing from Building Entrance to Bottom of Cable Shaft, Grant Avenue Central Office. 5—Cables Entering Howard Street Central Office, to Pass Up Through Wall Ducts. 6—Cable Splices. Ten Thousand Wires Joined to Ten Thousand Others. Upper Ends Insulated with Wool, Lower Ends with Paper. Part of Equipment of Howard Street Central Office. 7—Storage Battery Plant. 8—Cables Passing from Top of Shaft to Main Distributing Frame on Floor Above.

urban lines and equipment are furnished for a large anticipated two-number traffic. The two-number method referred to is that in which the telephone company undertakes to connect the calling subscriber with a called station and not to provide a conversation with a particular person at that called station.

With a view to co-operating with an extensive long-distance system, quarters and equipment have been reserved and designed. The designs include a broad use of composite and simplex circuits for simultaneous telegraphy and telephony.

The trunk line connection between San Francisco and most of the suburban points is to be made through steel armored, lead encased, paper insulated, submarine telephone cables.

The general design of lines and apparatus contemplates the ability to connect long-distance lines with the lines of San Francisco patrons, and to furnish, by these means, a high-grade long-distance service between any San Francisco telephone of the Home Telephone Company and all other independent telephones within the range of the long-distance system as it shall extend.

The general offices of the company are located in the principal telephone building in Grant avenue, near Sutter street. That building is of seven stories, with a large basement, and provides room for present and future administration, for the automatic switching of all the lines of its district and for the equipment necessary for both suburban and long-distance traffic.

The building is of steel frame construction, the exterior being of Colusa sandstone. It is classic in design and the architects have expressed in their work the thought that the building is used for but a single purpose. This is made evident by the undivided treatment of the facade, a unity so seldom seen in buildings.

The Corinthian colonnade comprises three of the upper stories in height and is the dominating feature of the facade. This is crowned by the classic entablature and cornice which take in the top floor of the building. The order is raised on a base three stories in height from the sidewalk line.

The architectural scheme of the interior of the public office follows the exterior in simplicity and dignity. The ceiling is octagonally coiffured and is supported upon columns and pilasters of the Corinthian order. The illustration which heads this article gives some idea of the effect.

A special building, complete and in use for a year or more past, provides warehouse and shop facilities with adjoining outdoor storage for heavy machinery and supplies.

The unquestionable popularity of the automatic system justifies the expectation, based on actual experience, that the system in San Francisco and the surrounding territory will be so thoroughly approved that a great and rapid expansion of the scope of the plant is purely a question of time.

To controvert the theory of the impracticability of the dual telephone system, it is only necessary to state that its introduction, under proper auspices, in any community has in every instance been the signal for a phenomenal growth in the general use of the telephone, with the resultant fact that the business man and the individual from his residence find themselves able, in a comparatively short time, to talk with far more than double the number of people by telephone that they could before; and the wonderfully increased conveniences and facilities resulting therefrom furnish much more than an offset to the previously supposed annoyance of more than one telephone.

The total present installation of the San Francisco Home Telephone Company is 15,000 subscribers' lines. These are divided among the four present exchanges as follows: Central office has 5,000 lines, West and Howard offices take care of 3,500 lines each, and 3,000 lines are handled by South office. The Keith line-switch is used throughout on the two-wire system. In this connection a brief description of the Keith unit may not be amiss.

A line-switch board of 100 lines comprises four groups of 25 each of the Keith line-switch mounted in two sections; that is, two groups one above the other on the right and in a similar manner on the left. Each individual switch is insulated from the mounting frame and from the others and is rigidly held in place by two screws, which, in turn, are insulated from the frame. By giving these screws one or two turns the switch is loosened and may be readily removed. Each section is provided with a plunger shaft to which is connected a master switch located between upper and lower groups. The common practice, however, is to reserve one master switch by disconnecting it from its plunger shaft and then link the two shafts together, allowing one master switch to operate both plunger shafts in unison. On the rear of the line-switch board are mounted the connector switches which make the final connection with any one of the lines of the line-switch board. On the left, as seen from the line-switch side, is a slate terminal to which power, generator and busy signal wiring is brought from the main power board. From this slate terminal connections are made through fuses and signal lamps with the various circuits of the line-switch board. Each section of line-switches is mounted upon a hinged frame or door so arranged that by removing a bolt at the top and bottom the section may be swung through an angle of ninety degrees, giving access to all wiring of the board.

An interesting and important feature of the line-switch board and its trunk switches is the system of tell-tale and supervisory signals. Not only are all heat coils and fuses provided with alarms, but also supervisory and tell-tale signals are placed upon the trunk or first selector switches. The first selectors have two supervisory signals. One signal lamp, which is individual to a switch, glows when a line-switch is tripped onto the trunk and the corresponding first selector remains in a normal position. After the switch operates, however, and the side switch wipers pass to third position, the signal disappears. A second signal, or group lamp, is wired so that when any first selector of a group of 10 is in a fully operated position a red lamp may be caused to glow. But, as it is undesirable to have this signal glowing all the time any one of the ten switches is in use, the lamp circuit is provided with a snap switch and the signal may be controlled as desired.

The trip magnet is energized by the preliminary impulse over the rotary line conductor. The trip magnet armature is withdrawn from the end of the plunger arm against the trip magnet cores. The plunger arm, in response to the spring tension, moves about its pivot point and thrusts the plunger into one of the bank terminals. When the trip magnet de-energizes the armature falls against the end of the plunger arm. The switch is restored when the release magnet becomes energized so that it attracts the release armature and in turn moves the trip armature upwardly until the catch falls over the end of the plunger arm; then, when the release magnet becomes

de-energized, the armature returns to normal position, withdrawing the plunger from the bank.

The master switch comprises a frame upon which is mounted a motor magnet, ratchet wheel, motor-magnet relay, resistance lamp and interrupter springs. Also, pivotally mounted on the frame, is the motor-magnet armature upon the end of which there is a pawl which engages a tooth of the ratchet wheel when the motor magnet is energized. When the motor magnet energizes and attracts its armature the interrupter springs are separated. The means for restoring the armature to normal position when once attracted lies within a flat spring mounted upon the same bracket with the interrupter springs. Rigidly secured to the ratchet wheel there is a toothed fiber interrupter wheel designed to control a pair of springs. The motor-magnet relay controls three springs and when energized places in contact with each other the two outside springs whereby a circuit is closed through the motor magnet. Normally, however, the two inside springs are in contact and battery is fed through them to the trip magnets of the line switches. Connected with the ratchet wheel is the connecting link, which latter, in turn, is pivotally secured to the plunger shaft. This connecting link is so arranged that when the ratchet wheel is rotated the plunger shaft is given a backward and forward motion. The master-switch bank comprises a group of ten individual segments and one common metallic segment. Sliding over these contacts in unison with the backward and forward movement of the plunger shaft is the master-switch bank wiper, adapted to maintain some one of the individual segment in electrical connection with the common segment at all times. The master switch is operated when the subscriber turns the dial on his instrument for the first digit of the number he is calling.

The situation of the city of San Francisco renders it peculiarly adapted to the successful installation and growth of a telephone system. Surrounded as it is on three sides by water, it has through the lapse of years, become more dense and concentrated than any other city on the continent, outside of New York, and the geographical position of the city is such as apparently to insure for all time its pre-eminence as the commercial and financial center of the Pacific coast.

Given, therefore, a peculiarly strategic point for telephone service, together with the most absolute assurance of growth in population of the city, allied with an excellent telephone mechanism, and the result is an unusually auspicious prospect for the Home Telephone Company of San Francisco.

Telephone Traffic the Pulse of a Big City

It is not a new saying, but it is none the less true, that the business pulse of a great city is visibly and audibly shown in its telephone exchange.

In Chicago the telephone calls about three o'clock in the morning are so few in number as to indicate that the city is well-nigh asleep. Rising, hour by hour, to the full tide between ten and eleven o'clock each morning, when tens of thousands of calls are handled in many of the great exchange offices, the pulse of the city is beating hardest, and a full life for that particular day is indicated.

Slackening up a little at the noon hour, the pulsations indicated by the thousands of telephone calls rise again in the afternoon before the closing of business hours and again fall off at the coming of night.

If business is good in a city the number of calls for each telephone during each hour and each day indicate that fact. If business is poor the telephone calls diminish in number.

Going from a period of business activity into a period of depression the total calls month by month are on the down grade, the business pulse of the city is weakening. When the bottom is reached the fact is indicated by the comparatively even number of telephone calls day by day.

When the upgrade in business activity begins the telephone pulse beats faster, and the total daily number of calls begins slowly to increase, and the continued approach of good times is indicated in the upgrade of the chart of the city's telephone pulse.

This activity is affected also by the months of a year. After the rush of the season approaching the holiday's business, as indicated by telephone calls, it falls away in January, slowly begins to recover in February, is more active in March, has its greatest activity in the spring months of April and May, begins to fall away in June and July, reaching a minimum in August, slowly rising through September to the high peaks of the year, November and December.

Observation of the chart of these calls for 1908 and the first part of 1909 indicates that the bottom seemed to be reached in the telephone pulse of Chicago in August, 1908.

The upturn was not noted until the first of October. Since that time, however, the tendency has been slowly but surely upward, and the use of the telephone during the past two or three months has certainly indicated that business in Chicago is on the upturn.

It must be remembered that the telephone is affected not only by one class but by all classes of business. It serves the requirements of every one, and is in that respect a very general indicator of business activities.

Certainly business, as indicated by telephones, is better. More telephones are being installed each day and each month than a year ago; the demands upon the company were never so great; new buildings, new subways, conduits, cables and telephone plant extensions of all kinds are being made, and still the demand for extensions of new service keeps up.

Within the city the company is operating now nearly 185,000 telephones, handling about 1,200,000 calls per day. The average distance covered by each call is not far from three miles. Thus, telephone messages every twenty-four hours in Chicago are carried more than 3,000,000 miles.

Nearly every room in every hotel in the city is equipped with a telephone. The exchange instruments are installed in about 90,000 private residences.

Every large business has its own branch exchange, and still the number of patrons and the volume of service increase, and there are few among us who would attempt to prophecy the ultimate growth of this great system of intercommunication.

A Strong Independent Company

The Johnstown Independent Telephone Company, operating at Johnstown, Pa., has paid dividends of thirteen per cent for several years, and has set aside a large annual surplus besides. The stock of the company is selling at three times its par value.

That the plant has been properly maintained is shown by the following extract from the annual report of the company by its president, Charles Griffith:

"Your property today is in much better physical condition than ever before, and is unique and stands alone

among plants in cities of our class inasmuch as eighty per cent of its lines are in underground cables and conduits. The first cost of your underground plant is considerably in excess of pole line cable and open wire construction, but is fully warranted when we take into consideration the factors of service, permanency, renewals and reconstruction, and that the maintenance is reduced to a minimum, one inspector, or trouble man, being all that is required in that department. The proof of this is the fact that the ratio of cases of trouble reported monthly is constantly decreasing. Eighty per cent of the cost of your plant is composed of lead, copper, underground conduits, and masonry. All of these materials are almost indestructible when properly installed and protected, and, expert telephone engineers claim, will last a lifetime.

"Approximately ninety per cent of your property lies motionless and free from wear and tear, while in most all other public utility plants approximately ninety per cent of the cost consists of heavy machinery and materials subject to wear and tear of rapid motion which tends to depreciate the property quickly.

"On account of having passed through a period of depression during which time nearly all of the public service corporations and larger industrials in the United States showed decreased earnings, it is a source of much pleasure and satisfaction to make this report, which shows not only a gain in number of telephones, during the past year, but also a substantial increase in earnings.

"It has been suggested from time to time to many of you personally, in conversation and otherwise, that it was believed the telephone business would suffer less in a time of commercial depression or business panic than most any other enterprise. Now it is an assured fact. It is demonstrated that the income of a well conducted telephone company is less affected by such business disturbances than almost any business enterprise in the country."

North Dakota Independent Convention

The convention of the North Dakota Independent Telephone Association was held at Devil's Lake July 9 and 10, and was the largest and one of the most beneficial conventions ever held by the organization. About forty delegates were present, a greater number than have ever attended any of their conventions heretofore. In the absence of President Jacobson, Vice-President L. C. Lane officiated.

Friday afternoon, after the meeting had been called to order, President Kerlin of the board of trade gave an address of welcome in behalf of Mayor Whitman and the people of Devil's Lake, which was responded to in a very appropriate manner by C. H. Tolan. Interesting papers by L. B. Richardson and C. H. Core of Minot were read before the convention, and Hon. John Carmody also read a paper upon legislation, which was well received by all. After these papers had been read an interesting discussion took place before the convention on standardization. An investigation proved that there were 225 telephone companies operating in North Dakota, and although they do not all belong to the association as yet, they are rapidly coming into it.

Saturday morning, after the convention had been called to order, Col. Joseph M. Kelly gave an address of welcome in behalf of the Commercial Club of Devil's Lake, responded to by President L. C. Lane. A paper contributed by Miss Margaret Quigley, chief traveling operator for the Northern Telephone Company, was read before the convention, after which the time was given to the discussion of better service and compensation of employes.

The convention closed with the election of officers and the selection of the next meeting place. Minot was chosen for the 1910 convention, and the following officers were elected:

President, Hon. John Carmody, Hillsboro.
Vice-president, J. Hegge, Hatton.
Secretary and treasurer, L. C. Lane, Kensal.

After the adjournment of the convention the delegates were the guests of the local automobile club, and about ten cars carried the visitors to Chautauqua and various other places of interest about the city. On their return to the city a lavish banquet was served to them in the dining room of the Hotel Sevilla, at which music and various other entertainment was furnished.

General Courtesy

By courtesy is meant that polite and considerate treatment of persons with whom we come in contact that should be naturally born in, and inherent to, men and women, says T. W. Milburn in the *Southwestern Telephone News*.

By "general courtesy" we mean such treatment of the general public and of our co-workers as we would like to receive ourselves. In every department of its business, by personal contact, or by mail, or by telephone, the telephone company's employes should treat its patrons exactly as if the patrons were personal friends of the employes; we should study our attitude and address, in connection with our business, to see if we do show proper consideration to our patrons. The treatment we would ourselves expect will always prove a reliable guide in the treatment of others.

We should consider that a friendly smile is always in order and will often cool down an irate person at once—that a nod of recognition and a pleasant word will tend to make the subscriber pleasant. A gruff tone of voice should especially be toned down—and especially over the telephone.

A good many of our people are naturally pleasant, but there are some who are unintentionally lacking in those little courtesies that we all like to observe. You know how it is when you enter a store. If clerks are all busy you feel neglected, you feel that enough clerks should be provided; but if some clerk will give you a pleasant nod and say, "I'll attend to you in half a minute," you will feel better disposed.

Do not be careless or listless, but be awake, quick and active, and show the people who are waiting that you are trying to get to them, and when you do get to them say just a word or two in apology.

Corporations have bad names in this matter. People generally think that we are hardened; that we feel that they are at our mercy and that we feel that any kind of treatment is good enough for them; but I would be glad if all of our people would especially study this matter of courteous treatment, so that after a while it would be talked about town that "Those telephone people are mighty decent to deal with." We do not want any cringing or any unnatural acting, but just common, everyday acknowledgment of the fact that we are glad to meet our patrons—glad to carefully hear their complaints—and glad to do out utmost to promptly remedy their troubles.

How to Read Telephone Circuit Diagrams

By David S. Hulfish

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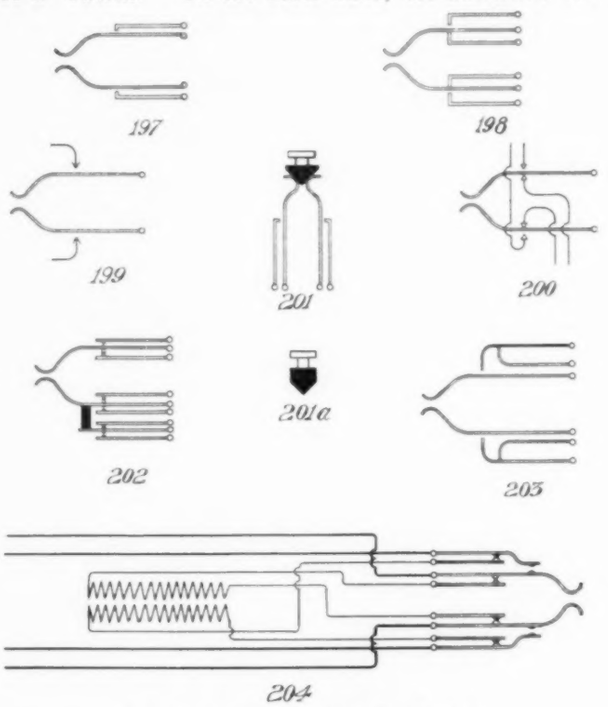
LESSON VIII.

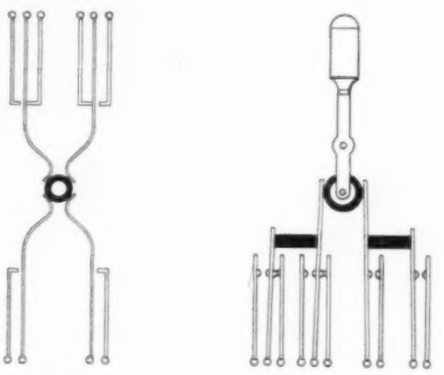
AN electrical switch, as the term generally is used, means any kind of electric circuit-changing or circuit-controlling apparatus. This definition should not be taken so broadly as to include current-controlling apparatus. To constitute a "switch" there must be the idea of changing the path of the current, rather than changing the value of current; indeed, the switch has to switches, although by some special current combinations even they properly may win that title.

The simplest of switches perhaps is the so-called "two-point" switch, which consists of a fixed terminal and a movable terminal, the fixed terminal usually in the nature of a screwhead and the movable terminal merely do with the path rather than with any current which may be flowing in the path. A switch must separate two conductors or join two conductors, or both, to come within the definition given; hence the variable-resistance transmitter and other devices which are merely current-controlling devices in nature are excluded from the class of a simple lever which may be moved upon the screwhead or away from it. It would be well illustrated by the symbol of Fig. 211 with the small circle at the right omitted. In Fig. 132 it was shown open. In Fig. 133 it was shown closed. This simple device bears the title of a "switch." On the other hand, the automatic tele-



Figs. 197 to 204. Telephone Key Symbols.

phone central office is equipped with "switches." An apparatus approaching in size a self-playing piano and far surpassing the piano in complexity, containing usually terminals of one hundred subscribers' lines and sometimes as many as twenty trunk circuits, with operating magnets and relays and pawls and wheels and springs innumerable, adapted as whole to connect any one of the one hundred subscribers' lines to any one of the twenty trunk circuits, also bears the simple title of "switch,"



Figs. 205 and 206. Combination Keys.

sometimes amplified to "automatic switch." Verily, this word "switch" is a broad and comprehensive word.

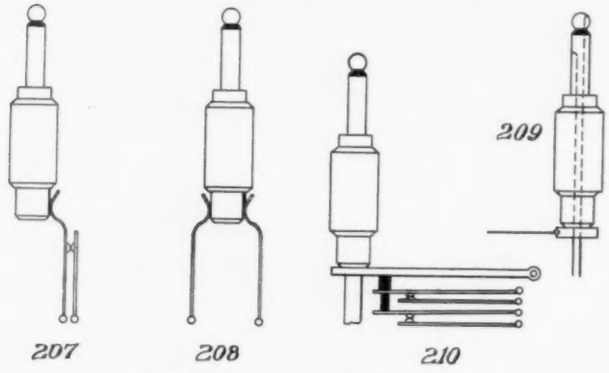
Switches will be discussed under three principal classes, viz.: First, the manual switch or key; second, the electromagnetic switch or relay, and third, the automatic switch, which is a relay or system of relays so highly specialized as to form a class for itself. The intercommunicating switch is a manual switch developed for the same end as the automatic switch, and may be classed with automatic switches.

The key, or manual switch, as used for the purposes of telephony, takes the form of a few small flexible springs operated by a handle. Usually the springs are mounted upon one side (the under side) of a horizontal or inclined shelf, called a keyboard, and the operating handles are upon the upper side of the shelf. The handles may be in the form of push buttons, or in the form of rocking knobs or short levers. The symbols will show them in both forms. The push-button key is the older type, but being the easier for the draftsman it is still used largely in diagrams even where the more modern lever key is in fact the device to be represented.

The push-button type of key usually presents an edge view of a flexible spring or short light arm, with a knob upon the side of the spring, or arm, indicating that the part is to be bent or moved by means of the knob. The lever type of key usually presents a pair of springs which are to be forced apart, sometimes showing also the plunger which is to be forced between the main springs to spread them. The general principle is that a main or moving spring is shown, or a pair of them, and about these are grouped the auxiliary springs, sometimes called contact points, from which the main springs break contact and with which they make contact, the auxiliary springs frequently being arranged to make contacts and other switching conditions among themselves.

In Fig. 197 is shown a symbol for a simple form of double-spring key. This is the symbol usually shown for tthe operator's listening key. If the two long springs were connected to the two sides of a telephone line, and the two short springs or contact points were connected to the two sides of the operator's telephone equipment, the operator's telephone would be connected to the telephone line whenever the two main springs of the key were spread by a plunger forced between them. Note the key symbol at the left in Fig. 135.

In Fig. 198, the symbol usually used for the operator's ringing key is shown. In this key, the main or operating springs are each associated not only with outer contact springs with which the operating springs make contact when they are spread, but with inner contact springs from which the operating springs break contact when they are spread. By this means, the two conductors which are connected to the two main springs are taken away from the two conductors connected to the inner contacts and are connected to the two conductors connected to the outer contacts. In connecting such a key for ringing purposes upon an operator's keyboard, the inner springs lead to the answering plug of the pair, the main springs to the ringing plug of the pair, and the outer springs to the ringing generator of the telephone central office; thus when the operator moves the handle of this key the two switch plugs of the pair are cut apart, on both sides of the metallic line, and the ringing plug only is connected to the source of ringing current, so that the ringing plug only is rung upon. For these circuit connections with such a symbol, see the key symbol at the right in Fig. 135. The listening key of Fig. 197 and the ringing key of Fig. 198 differ from each other because of the requirements of service which are to be met in their use. The possibilities of different combinations in the springs of the keys of a telephone switchboard are countless. A very few of them will be shown in the symbols, since the study of a few key symbols will enable the principles of the symbols to be mastered, after which any and all variations will be read with ease.

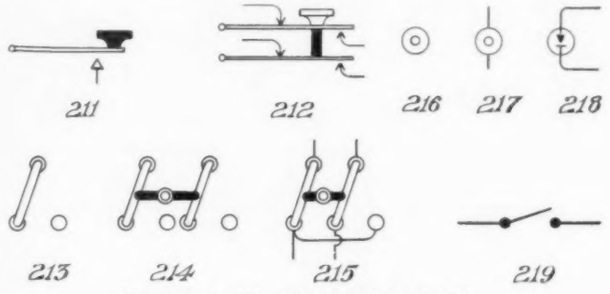


Figs. 207 to 210. Plug Switch Symbols.

The contact points or auxiliary springs of the keys have but little motion, as a rule, and theoretically need not have any movement at all. For this reason they frequently are represented not as springs, but merely as contact points. See Fig. 199, which is a modification of the symbol of Fig. 197, and Fig. 200, which is a modification of Fig. 198. In Fig. 200, the main springs are in a path including the two conductors passing downward, so long as the springs are not spread, but when the springs are spread they are in a path including the two conductors passing upward. In many instances the contact points are represented by circles. See Fig. 228, also Fig. 69. Another modification of the symbol of Fig. 197 is presented in Fig. 201, where the plunger with push-button head is shown in the symbol. The key of the two symbols is the same. In the symbol of Fig. 201 also the springs are shown vertical. The vertical position of the springs has no significance electrically, but the position or direction of the springs may serve to identify the key which is represented, particularly if there be several keys electrically similar in any diagram.

Fig. 202 presents a symbol including below the main switches a set of three switching elements auxiliary to the main switching elements and electrically separate from the main sets. It is obvious that as many auxiliary sets of switching elements as may be desired, and having any desired switching relation, may be added to the symbol of any key.

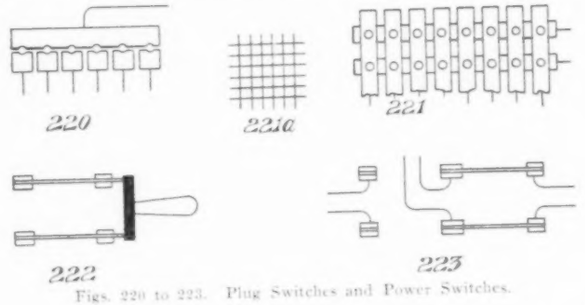
The symbol of Fig. 203 involves not only a fundamental principle in the construction of keys, but a fundamental principle in the reading of key symbols in a telephone circuit diagram. It is necessary to consider at times not only the switching conditions in the circuits when the key is in either of its two positions (most keys have but two positions), but also the conditions which exist from instant to instant as the key passes from one position to the other. In the key of Fig. 198 or of Fig. 200, considering the contact points of the key as rigid, the main or moving springs would break contact from the inner contact points before making contact with the outer contact points; thus for a moment the circuit leading to the main springs would be opened. As a ringing key, this is desirable, but for some signaling circuits it might be desirable to hold the circuit closed, changing the path of current from the inner contact to the outer contact without interrupting the flow of current for even the smallest interval of time. This requirement is fulfilled by the key symbolized in Fig. 203. As the operating springs are spread they engage the outer or longer auxiliary springs and for a brief period all three of the springs of each of the two sets are electrically connected with each other; then the longer auxiliary springs take up the movement of the operating springs and are lifted from the short auxiliary springs which in this instance may be regarded as fixed points which do not "follow" the longer auxiliary springs. It is possible, of course, that the physical key represented by the symbol of Fig. 198 may have its springs constructed in such manner that the inner springs may be adjusted to "follow" the moving springs until the outer springs have been picked up, but such a construction is not shown forth in the diagram of Fig. 198 as it is in that of Fig. 203, where the proper switching relation of the springs may be seen clearly and positively.



Figs. 211 to 219. Simple Switch Symbols.

A key of eight springs is shown in Fig. 204. This key is called a "repeating-coil key" because its arrangement of springs and contacts is such that it will insert a repeating coil into a pair of wires by a movement of its handle. This figure will be taken as an exercise in reading key symbols. The two positions of the key will be referred to as the normal position or position of rest, in which position it is drawn in the figure, and the actuated position. Normally, the telephone line or pair of conductors represented by the outer lines entering the diagram at the left passes to the long springs of the key, thence to the inner contacts and to the two ends of the upper winding of the repeating coil. The lower winding of the repeating coil passes to the lower short contact spring and the upper short contact spring of the key, thence to the two springs forming the top and bottom springs of the symbol respectively, and thence to the inner pair of conductors entering at the left of the diagram. When the main springs of this key are spread and the contacts assume their actuated position, the main springs are in contact with the top and bottom springs of the diagram, and the circuit through the key is shown in the heavy lines of the diagram, passing in upon the inner pair of conductors at the left to the outer springs, directly to the main springs and then directly to the outer pair of conductors leading out at the left of the diagram. The repeating coil, which is connected at its four terminals to the four fixed contact springs of the key, has the four terminals left isolated in the key so long as the key remains in its actuated position.

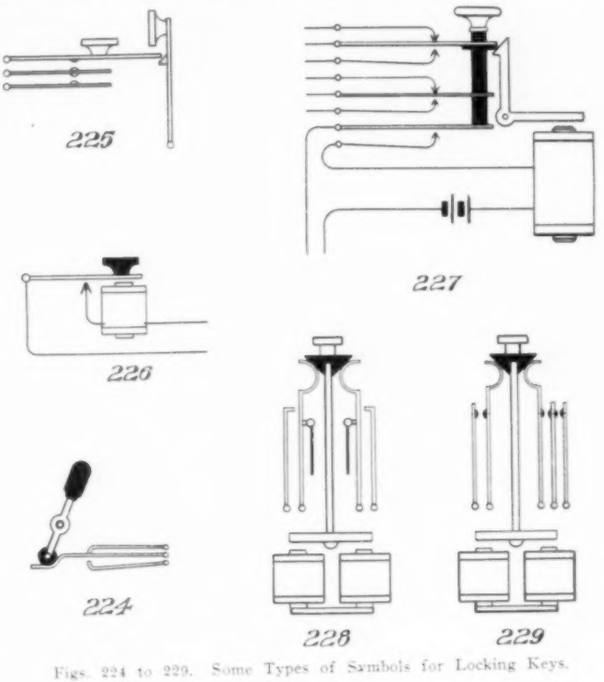
A key having but one handle, but having two systems of springs so arranged that either system may be operated independently of the other, is called a combination key. Such a key is represented by the symbols of Figs. 205 and 206. In Fig. 205 a plunger is represented as placed between two pairs of operating springs in such manner that it may be pressed between either of the pairs, operating either end of the key, but not both ends at the same time. In the key of the symbol, Fig. 205, the lower end is a listening key and the upper end is a ringing key, so that the operator, having listened or talked upon the cord pair, may ring upon the ringing plug of the pair by the use of the same handle which she will be required



Figs. 220 to 223. Plug Switches and Power Switches.

to use to remove her telephone set from the talking conductors of the cord pair. This type of key is met in diagrams of cord circuits. In Fig. 206 a key similar electrically, but differing in symbol, is shown. The different symbols probably would indicate to some extent the mechanical construction of the keys which the maker of the diagram had in mind. Other symbols also may represent a combination ringing and listening key, and may be so taken when appearing in a diagram of a cord circuit. See Fig. 230 and the comment upon it in this connection.

In addition to the manual switches or keys operated by the hand of the telephone switchboard operator, there are at times switches operated by the switching plugs when they are lifted from their position of rest, or are returned to their position of rest. These are called plug switches, and four types are illustrated in the symbols of Figs. 207, 208, 209 and 210. In Fig. 207, the symbol represents a switch comprising in part a main or moving spring which projects into the path of the plug as the plug passes into its position of rest. The plug engages the long spring and pushes it against the shorter spring;



Figs. 224 to 229. Some Types of Symbols for Locking Keys.

when the plug is lifted, the springs are allowed to separate. By placing the short spring or contact upon the other side of the long spring the springs would be separated by the plug when it drops into its position of rest, and would be permitted to connect electrically when the plug is lifted. In Fig. 208 is symbolized a plug switch in which the body of the plug forms a part of the electrical circuit, circuit being closed between the two springs when the plug is in its position of rest. In a diagram including the symbol of Fig. 208, or even of Fig. 207, note should be made to determine whether the body conductor of the plug and its associated cord conductor are not in some way concerned in the circuits which are controlled by the plug switch. It may be that the engagement of the conducting spring of the plug switch with the conducting body of the plug in the diagram is only an incidental detail in the drawing, and does not represent a necessary condition in the circuit requirements of the diagram or of the system which it represents. That the body of the plug and its associated cord conductor frequently are involved intentionally in the circuits controlled by the plug switches is true, and some plug switches consist of nothing more than the engagement of the body of the plug with a conducting seat. The symbol of Fig. 209 is presented to represent this simplest type of plug switch. The rectangular element from which the conductor passes to the left is but a metal plate (or the equivalent) upon which the plug rests, and from which

the plug breaks its electrical contact when lifted. When the plug is in its position of rest, the left-hand conductor of the two conductors leading downward from the plug is in electrical connection with the conductor leading to the left from the seat plate of the plug.

Keys of the push-button type, having flat springs upon which the operating buttons are mounted directly, are typified in the symbols of Figs. 211 and 212. Fig. 211 is the standard symbol for a telegraph key. Fig. 212 shows a ringing key so far as circuits are concerned, but built upon the telegraph-key type of construction. This style of key structure is very widely used in diagrams. It is easy to draw, and shows clearly just what the switching action of the electrical element is, so that whenever and wherever met it may be understood easily. That it represents mechanically the key which it symbolizes is not to be assumed in any instance. This type of symbol is encountered again in Fig. 227.

Simple lever switches are symbolized in Figs. 213, 214 and 215. Fig. 213 shows a single-pole switch and Fig. 214 shows a double-pole switch. These symbols will be understood without explanation. A specialization of the simple lever switch is shown in Fig. 215, and is known as the pole-changer switch. This type of combination of switching elements may be met in other forms, but frequently in the form shown in the symbol of Fig.

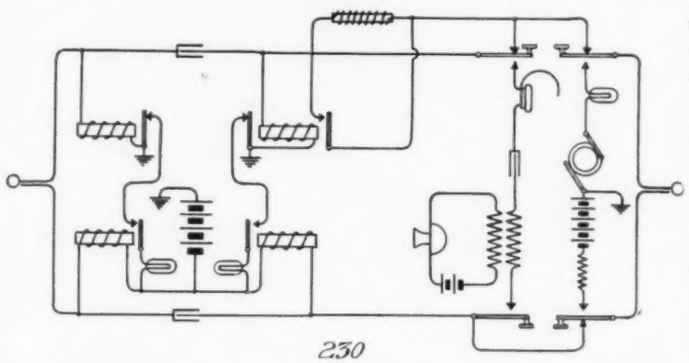


Fig. 230. Skeleton Diagram of a Plug Pair.

215. There are two levers and but three switch points with which the two levers may engage; the middle switch point always is engaged by one or the other of the two levers. The function of the switch is to reverse the relation of the two pairs of wires with respect to each other. When the switch levers are in the position shown in the figure, the left-hand wire at the top connects with the left-hand wire at the bottom, and the right-hand wire at the top connects with the right-hand wire at the bottom. When the switch is in its reversed position, the levers being upon the middle and right-hand contact points, it will be seen that the left-hand wire at the top is connected to the right-hand wire at the bottom, and the right-hand wire at the top is connected with the left-hand wire at the bottom. If the upper pair of wires were connected with a battery, then by the change of the switch the potential would be reversed upon the lower pair of wires, or the direction of current flowing over the lower pair of wires would be reversed.

The symbols of Figs. 216, 217 and 218 are selected symbols representing the ordinary push button such as is used for door-bell work. They are given here that such symbols may be recognized as switches or push buttons, and not as transmitters, which they resemble very much. See particularly Fig. 30. Figs. 216 and 217 are simple pictures of the door-bell push button, taken at a front view, while Fig. 218 takes note of the electrical elements of the switch. In telephone circuit diagrams they are most likely to be found in substation circuits. Fig. 219 is a switch symbol which is most noncommittal as to the mechanical construction of the switch represented, and it is therefore a very broad type of switch symbol.

Fig. 220 is a plug switch. Figs. 207 and 210 have the same name, but are fundamentally different. In Figs. 207 to 210 and the class of plug switch represented by them, the plug usually is independent of the switch operated by it and the plug serves only as a mechanical means for operating the switch. There is about the same relation between the plug and the plug switch as there is between a receiver and a hook switch. In the symbols and devices of Figs. 220 and 221, however, the plug is an element of the switch, has no other function, and exercises a selection among the possible circuits of the switch by the position in which it is placed. The plug in this case is a small cone or wedge of conducting material and connects two pieces of metal by touching both of them, as by being wedged between them. By inserting a conducting plug into any one of the circular openings between the long bar at the top and the small squares below it in the symbol of Fig. 220, a connection is established between the conductor leading out of the top of the symbol and a selected one of the conductors leading out of the bottom of the symbol. Such switches are common in lightning-arrestor equipments for substations, and in testing apparatus. They are used largely also as battery switches, and in telegraph circuits, because of their large carrying capacity compared with their compact form.

Fig. 221 symbolizes an ancient type of telephone switchboard, and sometimes it is used in later days as a symbol for a switchboard taken as a whole, without detail. Fig. 221*a* shows the more compact form of the symbol of Fig. 221. Horizontal conducting straps run from left to right, and the vertical straps cross them without touching them. The small circles represent holes drilled through both of the straps, and by inserting a conducting plug into any of the holes the plug would pass through both of the straps and engage both the upper and lower straps, connecting them electrically. By this means, any vertical strap could be connected to any horizontal strap, or any number of vertical straps could be connected to the horizontal strap. In the earliest type of switchboard, every telephone line had a vertical and a horizontal strap, so that each line crossed every other, and one plug would connect any two lines. An improved type had the telephone lines on short vertical straps only, the long horizontal straps being used as connectors, and two lines being connected together by connecting them to the same cross strap, using two plugs. This type of switchboard required but one-tenth the space of the former type, but it was displaced by the switchboard having the movable plug with the flexible conductor.

In Figs. 222 and 223 are shown symbols of double-pole power switches. These are met in the power-plant portions of telephone diagrams, including the batteries of the switchboards. Fig. 222 shows a single throw switch and shows the handle by which the switch blades are lifted from the switch brushes. Fig. 223 shows a double-pole double-throw switch, omitting the operating handle. The central pair of conductors may be connected to the right-hand pair of conductors or to the left-hand pair, as desired.

In many keys, the circuit controlled by the key is required to be closed but a brief period, during which period the key may be held closed by the hand, a spring being provided to return the key to its normal position and to restore its controlled circuit to normal also, when the hand is removed. For example, the push button of the ordinary door-bell, while not a telephone circuit, is suitable for illustration. This type of key is called a nonlocking key, in distinction from the locking key, which will stay in either position, remaining in its "normal" position until actuated by the operator's hand, and then remaining in its "actuated" position until restored to normal by the operator's hand. A "listening" key is a type of locking key. The operator presses the handle in one direction to connect her telephone with the desired telephone circuit, and the key "locks" and retains the connection between her telephone and the selected circuit until she releases it by pressing the handle in the other direction. Keys are locking or nonlocking according to the requirements of the circuits in which they are found, but, strange to say, the circuit diagram very seldom indicates whether the key is locking or not, unless some special means is provided for locking or unlocking it.

In the symbols of Figs. 197, 198, 199, 200, 202, 203 and 204, the key symbol does not reveal any means for holding the key locked in either position. With the symbols of Figs. 197 and 199 connected in circuit as listening keys, it would be evident that they were locking keys, and with the symbols of Figs. 198 and 200 used as ringing keys, it would be evident that they were nonlocking. It is evident also that the key of Fig. 204 is locking, to retain the repeating coil in the circuit until the operator desires to remove it. With the key of Fig. 201, the locking feature might be shown by showing a plunger of the shape shown in Fig. 201a, as a plunger of that shape would remain between the spread springs until pulled back by the hand of the operator, if pushed far enough so that the springs of the key would ride over the angle and upon the parallel surfaces of the plunger. Note again Fig. 135. The key at the left is locking; the key at the right is nonlocking. That such a showing should be made to indicate the locking nature of the key is largely at the option of the draftsman, and the draftsman can not be depended upon. Unless some special provision is made for the locking of the key or for the release of the key, which by reason of its electrical nature must be shown as a part of the electrical diagram, the locking or nonlocking nature of each key must be determined from the requirements of the circuit in which the symbol for the key is found. Some specialized locking keys are shown in symbol in Figs. 225 to 229. The symbol of Fig. 224 is shown to reveal the small difference between a locking and a non-locking key, a difference so small that the draftsman overlooks it or neglects it, leaving the circuit requirements to determine that feature of the key symbolized. If the lever of the key shown in Fig. 224 be pressed far enough, the black insulating roller at the lower end of the lever will pass the shoulder of the main spring of the switch and the handle will stay over, therefore locking the key; if, however, for some mechanical reason not shown in the symbol, the handle can not be pressed over so far that the black insulating roller will pass the shoulder of the main spring of the switch, the tension of that spring against the roller will force the handle back into the normal position shown, the key will not retain its actuated position unless held by the hand of the operator, and the key is a nonlocking key.

In the symbol of Fig. 225, a key of the push-button type is shown with an auxiliary arm or spring having a latching tooth for locking the main key lever down. In this key, a pressure upon the horizontal knob will close the switch springs together, and they will remain electrically in connection until the vertical knob is pressed to release them. This symbol probably is highly symbolical, although it follows closely the mechanical construction of a well known testing key used in galvanometer measurements.

Fig. 226 shows a symbol representing an electromagnetically locking key of the push-button or telegraph-key type of symbol. When this handle is pushed down it will close a circuit, and if there be current flowing in the circuit as a result of the closing of the key then the key will remain closed until the circuit is broken at some other point, to de-energize the magnet and release the key here shown.

In the symbol of Fig. 228, a magnetic latch is symbolized. In this symbol it is shown that when the key handle is depressed the key is locked in its actuated position by some sort of latch which has an electromagnet so arranged that when the magnet is energized by a sufficient current it will withdraw the latch and release the locking key.

Figs. 228 and 229 show two symbols somewhat similar. Both of these differ from the symbol of Fig. 227 in the detail that the electromagnet must remain energized as long as the key is required to hold its actuated position, the key returning to its normal position as soon as the holding electromagnet is de-energized. In the symbol of Fig. 227 the condition was reversed, the key remaining locked after actuation as long as the magnet remains unenergized, returning to normal upon the first energization of the magnet.

There is a possibility that the keys symbolized in Figs. 228 and 229 are intended for operation either manually or electrically, that the mechanical design of the key is such that it may be operated by pressing upon the knob at the top with the hand, or by energizing the magnet at the bottom so strongly that it will pull the central rod down, carrying the plunger with it to spread the springs and operate the switches. Any symbol must be read to satisfy if possible the circuit conditions required of it. Standing alone, without circuits or connections of any kind, it may have some possible interpretations which would be absurd when the symbol is found connected in a circuit diagram. Refer to the symbols of Figs. 226 and 227. In both of these symbols the electromagnets are energized only through the contacts of their own keys, so that it is impossible to energize them until after the key has been depressed manually. The circuit connections of Figs. 228 and 229 when found in complete diagrams should show clearly the operation of the keys, if any doubt exist from an inspection of the symbol alone.

Fig. 229 presents one symbol of a three-position key. It would seem from the symbol that when the knob is depressed part way the main springs will make connection with the two springs next to them without connecting at all with the outer spring of the group of three at the right, and that by the further movement of the knob the outer spring at the right would be connected with. This is a construction frequently met with in intercommunicating keys and sets, and will be shown in symbols and discussed in connection with the discussion of that class of switch. In the switch symbolized in Fig. 229 it is probable that by the depression of the operating knob to the full depth possible the three springs at the

right are connected and that then the knob is allowed to return part way, the electromagnet at the bottom operating to lock the key in such position that the main springs are held in contact with the springs next to them, leaving the outer spring at the right isolated.

Fig. 230 is presented as an illustration of the embodiment of symbolized keys in a telephone circuit diagram. In this diagram we have a plug pair. The plug symbol at either end is that of Fig. 177. The two plugs are connected by sundry apparatus parts, all presented in recognizable symbols, and including two keys. Apparently there are four keys; there are four key levers and four knobs for actuating them. Two of these levers have the knobs on the under side of the lever, indicating that the knob is to be pushed up to actuate the key, and that the key as shown is in its normal position. The operator's telephone equipment is shown with head receiver, condenser and induction-coil secondary in series, extending from the open contact of one of the upper keys to the open contact of one of the lower keys. By this it becomes evident that the upper and lower keys just above and below the operator's set are the two halves of the operator's listening key, shown separated for draftsman's convenience and possibly for reader's convenience as well, since the wires thereby are permitted to take more direct and shorter paths to their destinations. It is seen also that the two keys at the right, one above and one below, are connected to the right-hand plug and are adapted to separate the two plugs and to connect the right-hand plug to the system of apparatus which contains, apparently, a lamp, an alternating current generator, a battery, a resistance and an earth connection. These two keys are the two halves of the ringing key, separated for convenience. The four keys are listening and ringing keys of the ordinary type electrically and probably of an ordinary type mechanically, the listening keys operated both halves by a single handle, locking, and the ringing keys operated both halves by a single handle, nonlocking; or even a combination key, with one handle for all of the springs, similar to the construction of Figs. 205 or 206.

(To be continued.)

Correspondence

Editors TELEPHONE ENGINEER:—When I first saw your publication I was glad to know that at last some one was going to give a little time to helping along the cause of the telephone engineer. That sounds strange, does it not? Well, I guess you are doing your best to help along the cause, so far as TELEPHONE ENGINEER is concerned, but you do not devote enough space to discussing the real telephone engineer. If you have any one on your staff who can define the position the telephone engineer occupies in relation to the telephone industry, why don't you say something about him?

Your paper stands for competition. You write long editorials on the subject and discuss the advantages competition offers to the public, the investor, the operator, and the manufacturer, but you do not say a word about the telephone engineer, and what would any one of the above classes do if it were not for the telephone engineer? The telephone engineer, or any other kind of an engineer for that matter, is like a drug clerk. Any fool with money can open a drug store, can learn to order drugs when they sell and not to order them when they do not sell; but he must have a man to interpret the meaning of prescriptions and who has a knowledge of what the game is all about. Your paper could not exist if it was not for the telephone engineer, and you do not even give him a little help by "starting something" along the lines of defining his exact position in relation to the industry. You have not justified the use of TELEPHONE ENGINEER as a name for your paper when you publish articles relating to men that stand in the front row, although such articles may be interesting and inspiring to the young and unsophisticated.—A TELEPHONE ENGINEER.

A Telephonic Current-Detecter

Persons connected with the operating departments of electric light and power companies have felt the need of a satisfactory device for determining whether current is flowing in a cable or not. Valuable time is frequently lost in locating trouble owing to the trouble men not being provided with satisfactory testing outfits. Accidents have also occurred due to jointers cutting cables which they supposed to be "dead." Any system of numbering or tagging cables is likely to become wrong, due to changes, and should not be depended on absolutely, particularly with high tension cables.

The compass method of testing, while generally satisfactory for direct current cables, will not answer on alternating current. The testing outfit illustrated here is designed for use on alternating current lines, but is also satisfactory for direct current work, provided the current is supplied from a generator. It would not

Telephonic Current Detector in Use.

work on a battery circuit, as the sound heard depends on the commutating action of the generators.

The testing outfit consists of a telephone receiver and a small current transformer with a hinged core. The secondary wiring of the transformer is connected to the telephone receiver and the hinged core is clamped around or against the cable to be tested, the cable forming the primary of the transformer.

The device will be found very sensitive, and will work on single, duplex or three-conductor cable. It will be more sensitive on single conductor cables than on the others. On single conductor cables an alternating current of one ampere, or a direct current of two amperes, will give a distinct, audible indication in the telephone receiver.—*Popular Electricity.*

Characteristics of Dry Batteries

By F. H. Loveridge*

IT is not the purpose of this paper to go into a technical description of dry cells, but to give some of their characteristics, to indicate what classes of service they are best adapted to meet and to point out some of the precautions that should be taken to insure the best results in practical working. So far as the user is concerned a dry cell might be termed an "original package," sealed up tight, and must be accepted for better or worse, as received from the manufacturer. The user of dry cells cannot hope to improve or replenish them, though schemes of this nature are continually being proposed. None of them so far as I am aware ever proved to be of practical utility.

A dry cell is only so in name, for there is a considerable amount of moisture absorbed in the various ingredients—the moisture, however, is supposed to be all absorbed and not to be found as a liquid in any part of the cell.

The zinc containing cup used almost universally serves the double purpose of an electrode and an air tight receptacle in which are packed the necessary carbon and manganese dioxide moistened with the particular solution which each manufacturer prefers to employ.

A dry cell is classed as an "open circuit" source of electrical energy, and though this statement seems contradictory, still it is justified from the fact that the open circuit condition is the one expected during the greater part of its serviceable life.

The electrical energy of the cell is, generally speaking, a certain quantity and so long as it remains on open circuit none of the energy is drawn out. When the circuit is closed, however, energy is given off and the sum total is diminished correspondingly. It should be explained that a "certain quantity" of energy in the cell is intended to imply definite service conditions; as these conditions vary the available energy will vary and between wide limits.

In making a dry cell the aim is so to construct it that there is a balance between the various chemical elements, and so long as this balance is maintained, the cell is inert. When this balance is disturbed, either because of a closure of the circuit through an external path, or interaction between the contained chemicals, a change will take place which cuts down the available output. This interaction takes place when cells are "on shelf," which means the period during which they are stored preceding placing in service. In the course of time it will be noted that both the electromotive force and the internal resistance have changed in such a way that less energy is available.

It seems impossible to avoid this deterioration altogether for the reason that a large number of ingredients are used, and in practice it is impossible to have them chemically pure; some of the ingredients contain more impurities than others, as for instance—manganese dioxide, a natural ore, which is a commercial article with 85 per cent MnO_2—the remaining 15 per cent is made of various impurities more or less objectionable. The presence of impurities explains almost entirely why dry cells are never without some degree of internal action producing harmful effects no matter how insignificant.

For a time when cells are new these harmful effects seem to be of no particular importance, but as time goes on, their effect becomes more apparent, and finally, after a considerable period, cells when tested for available energy are found to have practically none. Some cells will deteriorate more rapidly than others, and it is one of the problems of the manufacturer to reduce "shelf" action to the lowest practical minimum. Efforts along this line have met with varying degrees of success. Various expedients have been tried, the most obvious of which is to make the cells absolutely dry and supply moisture when they are put into service. This plan, however, has its serious drawbacks.

The question of providing a condition under which the maximum energy may be drawn from a cell is one which is not of practical interest, but the question does come up as to the number of watt-hours available under various service conditions. If the rate of discharge is too high then the cell will not have time to recuperate properly or depolarize when the open circuit interval occurs. On the other hand, if the rate of discharge is too low, there is a tendency for the cell to use itself up internally and thus restrict the amount available. In tests which we have made, and from which this result is simply an inference, it seems that if the energy is drawn out under ordinary working conditions at such a rate that the cell is exhausted in a period of about a month, the maximum energy is obtained, but if the work is such that the time during which the cell is in service is extended over a year the percentage of the maximum amount of energy available is considerably reduced. This fact is to be accounted for on the basis of the longer period during which internal chemical action producing no current is going on. It is not to be understood from this that a cell may not be depended upon for long periods of service. It simply means that a reduced watt-hour output (which in itself may be more than sufficient for requirements), is to be expected.

In making the above statement it has been assumed that average temperature conditions prevail. It is a well known fact that there is an increase of chemical action at high temperatures and a decrease at low temperatures. Since the chemical action in a cell may be considered of two kinds, that is, first useful action producing flow of current in the external circuit and second harmful action, which cuts down the efficiency of the cell, it will be seen that the climatic condition under which the cell is stored or worked is very important. On "shelf" a cell will deteriorate slowly at low temperature and this deterioration will increase as the temperature is increased. Cells stored in a dry atmosphere where the temperature is kept below the freezing point of water will probably show no appreciable deterioration, whereas at 100 degrees F. or above, the effect of harmful action will be noted in a comparatively short period, hence the desirability

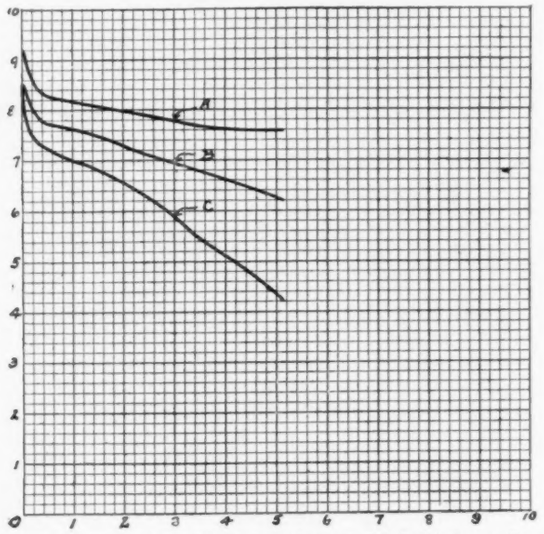
*Paper read at the convention of Railway Telegraph Superintendents.

of storing cells in cool places. Where cells are on light service, requiring only a small energy drain, it follows that the ratio of useless chemical action producing flow of current, will be low at low temperatures and high at high temperatures. Where the rate of energy drain is high, then the temperature is not of so much importance, because the time during which harmful action can take place is greatly reduced. It would be difficult to state this as a formula, but the general law is quite definite.

The internal resistance of cells does not seem to be materially affected by wide temperature variations. In one instance I have noticed an increase of less than .1 of an ohm while the temperature changed from 100 degrees F. above zero to 25 degrees F. below zero. This change of .1 of an ohm would cause a very large variation in the instantaneous ammeter, but the ordinary 2½ inch by 6 inch size is used almost exclusively in circuits requiring less than one ampere. Where the current is only .1 of an ampere or less, it will be seen that the increased resistance would absorb less than .01 of a volt. This would, of course, be insignificant in comparison to the total electromotive force.

There is a characteristic difference between "wet" and "dry" cells, in that the internal resistance enters as a very different factor in the two cases. The internal resistance of wet cells in general is fairly constant, while that of dry cells is a constantly varying quantity. When a dry cell is new, its internal resistance may be approximately .05 of an ohm, and it increases from this up into the hundreds of ohms. The magnitude of the internal resistance of the dry cell determines the age it has reached in its period of useful life.

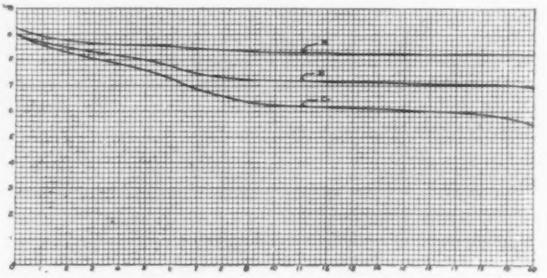
The accompanying two sets of curves bring out very strongly this factor of internal resistance. The test conditions were the closure of the circuit at cer-



Curve Showing Dry Cell Characteristics at High Discharge Rate.

tain intervals through an external resistance for a period of time which remained constant throughout the test. In the first set there is a high rate of energy discharge and in the second a low rate. The ordinates of these curves are expressed in volts and the abscissas in time. The three curves in each set marked *A*, *B* and *C* represent respectively the electromotive force on open circuit, the potential difference at the time of closure of the circuit through an external resistance and the potential difference at the end of a period, which is constant throughout the test.

It will be seen from these curves that at the start, the potential difference at the beginning of closed circuit and the potential difference at the end of the period are practically identical. The electromotive force curve is somewhat higher. As the cell is used, it will be noted that these curves diverge, and if carried far enough, the lowest curve would finally touch



Curve Showing Dry Cell Characteristics at Low Discharge Rate.

the line indicating zero potential. The high electromotive force on open circuit is of no particular value, because it indicates a condition where no work can be done. The instantaneous drop, when the circuit is closed shows the magnitude of the internal resistance when the current starts to flow.

The difference between the potential at the beginning of the period of closed circuit and the potential at the end indicates to what extent the internal resistance increases, or the "practical polarization." These curves give a very correct idea of the characteristics of the dry cell, and from them may be deduced most of the data which should lead to the proper use under service conditions.

As will be seen from the chart, the available energy from a cell decreases from the start. If the drain continues long enough the zero point will ultimately be reached. There is no reason why cells should not be left in circuit as long as they contribute an electromotive force to the current flowing, but if the potential of individual cells is allowed to drop to a very considerable extent, it will be necessary correspondingly to increase the total number in series so that the required potential for working conditions may be maintained.

The determination of the point at which cells should be taken out is something that must depend on the particular service condition. If in telegraph work there is a permissible variation in the current from 90 down to 60 milliamperes the average potential per cell could drop from 1.5 volts to 1 volt. When this point is reached the entire set must be replaced unless additions are made to the series. This expedient is often adopted and works out as follows: If there are 10 cells at the start, giving a potential of 15 volts (90 milliamperes), then when the potential is only 10 volts (60 milliamperes), the addition of one cell allows the average to come down to .91 volts per cell. Similarly, the average for 12 cells would be .833 volts, for 13 cells .769 volts, etc. Thus, cells can be run down to lower averages and more of the total energy utilized. If, however, this plan is carried too far and cells are left in circuit until they reach the zero point they become resistances which simply increase the circuit re-

sistance as though additional lengths of wire were inserted, additional work being thrown on the remaining cells. I believe the best practice is to set some potential difference at which the cells are to be taken out of circuit, thus preventing the number in series from becoming excessive.

I wish to call attention to the fact that if a sufficient number of cells to do the work are placed in a circuit, a large number is objectionable for the reason that too heavy a flow of current is produced. For instance, if 90 milliamperes be sufficient to operate the apparatus, then the addition of enough cells to bring the current up to 150 milliamperes would be decidedly objectionable since the flow of current in the circuit tends only to draw energy from the cells at an excessive rate. Where dry cells are used in circuits of widely varying resistance, this fact points to the desirability of determining the necessary electromotive force for each circuit and connecting the proper number of cells in series to give the required flow of current.

If the circuit resistance is known a voltmeter across the terminal of the battery will show whether or not there is sufficient electromotive force to produce the desired flow of current, or if the resistance is not known, a milliammeter will serve the purpose equally well.

I have understood that in general, for telegraph and block signal work, a current of 60 to 90 milliamperes is required. If the proper number of cells are put in circuit to produce 90 milliamperes at the start, the cells may be run down to a point where their internal resistance will be such that only 60 milliamperes will flow. It has been found by experience that where dry cells are installed as a unit, that is, a certain number in series which are all put in and taken out together, it is highly desirable to have cells uniform in quality and condition. One defective or run down cell among fresh ones will drag the others down so that the set is unfit for service before the fresh cells have given out their normal amount. The greater the degree of uniformity, the more satisfactory will be results.

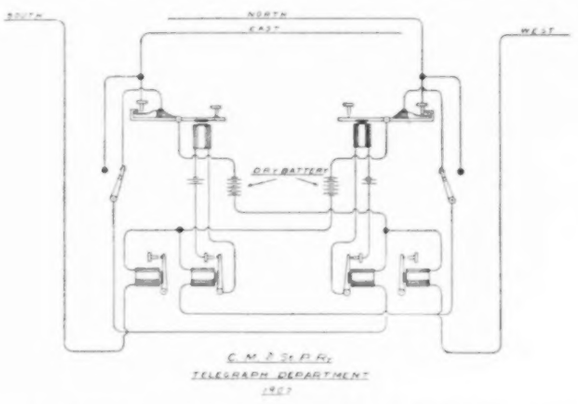
The use of dry cells in multiple is sometimes of advantage where the current drains are heavy and frequent. It may be that two sets of cells in multiple will work more than twice as long as either set by itself. A similar arrangement to meet similar conditions is to connect sets so that by means of a switch, one set is in circuit at a time, thus giving the other set or sets time to recuperate. The adoption of plans like the above must be determined by conditions.

I have mentioned the fact that after a time at average temperatures, the deterioration of cells comes to be an objectionable factor. It follows from this that cells should be put into service as fresh as possible. If renewals are to be required after a certain period, it is best to get fresh cells from the maker, rather than to order a large stock and keep them on hand for use when needed. Cells may become very old, if kept in stock following this plan, and they will not be found as satisfactory as the fresh ones. It is, of course, recognized that a number of cells must be kept in stock, but the number should be made as small as possible and they should be kept in as cool a place as is available.

Cells either in storage or service should also be protected from moisture, for the reason that short circuits may occur from the cartons, or paper boxes becoming saturated and forming conducting paths between the external surfaces of adjacent cells. They should also be protected from dust and dirt, because conducting particles may form accidental short circuits. If an accidental cross occurs between leading wires, it is apparent that there will be a very heavy energy drain, sufficient perhaps to cause the wires to become red hot. A heavy drain of this kind is so much loss to the total available energy, just as much as a leak in a tank would diminish the quantity of the contained liquid. Other drains on the energy supply may be made by connecting up buzzers, bells, lamps or signals, which, of course, will tend to decrease the energy available for the circuit in which it is desired to utilize the maximum amount.

Dry cells are liable to damage from rough handling. The wax used for sealing if cracked or broken tends to hasten the drying out of the interior. The resistance between the zinc cup and its lining may be so increased as to become a serious defect if the cell is subjected to pounding and there is also increased harmful chemical action.

My experiences with battery gauges is that they are not very reliable, and that their usefulness is confined practically to detecting cells which have reached such a condition that they should no longer be left in service. In the first place, their accuracy is no greater than should be expected where the price they bring is taken into consideration. Then, again, the method of making contact with cell terminals causes the readings to be exceedingly variable. By varying the contact in applying battery gauges, very wide variations in the readings may be made which of itself would be enough to make the instrument of questionable value. The position of the instrument and vibration are also factors which enter to determine the magnitude of the readings.



Current Diagram Showing Arrangement of Dry Cells with Telegraph Repeater for Maximum Efficiency.

There is this to be said in favor of battery gauges, and that is that where a certain gauge is used by an individual exclusively, he soon gets to understand the readings and can interpret them so as to obtain the best estimate of the condition of the cell which it is possible to obtain from the reading of the instrument.

When it comes to a question of determining the relative merits of new cells the gauge is of practically no value, unless there are "defectives" which it is desired to find. The battery gauge test, however, is

much to be preferred to the method sometimes used of short circuiting cells through a wire on which an ordinary compass is placed and judging their condition by the magnitude of the deflection. A test of this nature is not only a heavy drain on the cell, but the ratio between current flowing and deflection is not constant.

The best way to test cells in service is to allow the current to flow through its circuit under standard conditions and then to apply a high resistance voltmeter of good construction, noting the potential differences at the terminals of individual cells. By this method each cell will show what it is doing under regular working conditions.

For testing new cells a high resistance voltmeter is desirable to see if the electromotive force is up to normal and the instantaneous current flowing through a low resistance ammeter will give a good indication of the internal resistance. However, it does not always follow that the cell which will give the best service has the lowest internal resistance.

The question is often asked as to the quality of new cells of various makes or of various lots of the same make as determined by instrument readings. It is impossible to answer intelligently with only the limited data to go by. The only satisfactory determination is to give cells closely observed service test and from results form conclusions. Cells must have time to show their staying qualities and these can not be demonstrated in a moment. It is impossible to make cells that will give remarkably good initial readings, but which have no staying qualities, and the reverse is also true. The best plan for the user of dry cells is to determine by service tests the make adapted to his requirements which he knows he can best depend on as being reliable in quality and in uniformity of grade.

Mr. Fry has made a valuable investigation of actual conditions found in railway telegraph and block signal work. His data shows that the average time of circuit closure is less than five minutes per day. This is reckoned on a basis of 10 minutes total of telegraphing per day which would mean that there would not be more than 150 communications. As the open and closed fractions are respectively 5-9 and 4-9, the total closed period will not be over 5 minutes. The requirements as to flow of current are from 60 to 90 milliamperes, or say an average of 75. On this basis the watt-hours per cell per day would be expressed by

$$.075\times5/60\times1.25=.0078$$

or for 1 year

$$.0078\times365=2.847$$

on the assumption that the average voltage per cell is 1.25. Such an energy drain is very light and represents only a small portion of what would be obtained under ordinarily favorable conditions.

In the operation of telephones, the conditions are more severe—it is of course necessary for current to flow during the entire time of speaking into the transmitter, and though the transmitter resistance is constantly varying, it cannot be said to approach open circuit as in telegraph transmission. With high resistance transmitters a minimum of 140 milliamperes is required, and it may go as high as 320. With transmitters adapted for some railway work which have a lower resistance, a current not less than 300 nor more than 600 milliamperes would be used; we may say roughly that 500 would be about the average working strength. I have no data as to the length of time per day during which a telephone would be used, but the magnitude of current flow and its continuity indicate the severe condition of battery drain.

With the majority of telephone equipments for train dispatching now being recommended a key is associated with the transmitter and so arranged that when the user wishes to talk to the distant party, or in other words when the transmitter is in use, the key is depressed, thus closing the battery circuit. During the period when the distant party is talking the button is released, thus opening the local transmitter circuit and saving the cells from a current drain during the time it is not required. A device of this kind is also of benefit from a transmission standpoint, for the reason that if the cells are given intermittent service during conversation they will have a chance to recover during the intervals of open circuit, and will maintain a more nearly constant voltage on the transmitter.

I am indebted to Mr. Fry for a circuit diagram showing a very ingenious arrangement of dry cells used with a telegraph repeater. The arrangement is such that the current requirement of the dry cell is reduced to a minimum and the current energy is used to the best advantage. From the diagram it will be seen that only the set of dry cells on the receiving side is in service and that here the current flows only during the "space" or "open" period of the sending line. As the sending and receiving functions are alternated it will readily be understood from the diagram how the two sets of cells are alternately brought into action, thus carrying the reduction of closed circuit periods to its limit.

The numerous advantages of the dry cell for open circuit work are now being appreciated. The wet cell formerly used in telephone service has disappeared and with its exit has gone a source of annoyance and expense. The possibility of having a certain quantity of electrical energy in a form requiring no attention for maintenance, giving out its energy as demanded and so cheap that it may be thrown away when no longer useful is almost ideal. As time goes on the field of application will constantly widen until all requirements for a small amount of electrical energy used intermittently over a long period will be taken care of by the dry cell.

A Call from the Tall Timber

A call for help literally from the tall timber where some turkey hunters were treed by a pack of black wolves was received at Higginson, Okla., over a wire which had been tapped by one of the hunters, W. A. Cook, an official of the Independent Telephone Company, who had a transmitter and receiver with him, such as linemen carry. He had taken it with him to be able to talk from their camp, which they proposed to locate along the route of the telephone lines.

The urgent call was for some heavy ammunition. When the shells were sent out by a well-armed party the turkey hunters were found at the spot described in the tree tops, a large pack of black wolves holding them captives, according to the report received from Higginson. The wolves were driven off, some being killed, and the treed turkey hunters rescued.

Their sole comment was that it was lucky for them that the telephone wires ran through the trees in which they took refuge.—*Southwestern Telephone News.*

Some Questions Answered

By J. C. Kelsey

[This department is at the command of our readers. Questions relating to all branches of telephony—technical, financial, ethical, or otherwise—are invited, and will be answered in the order received. Names of inquirers will not be used unless desired.—*Editors.*]

As an independent telephone operator, I want to ask a question. In the last year and a half, I have heard three heads of prominent telephone manufacturing companies declare that the independent telephone business had seen its best days. These men are active members of the manufacturers' association. What is wrong?—J. H. P., Iowa.

Nothing is wrong. If you take candy to the children, they are greatly pleased and reward you as children do. If you make a regular practice of this for a week, you will be met at the door with the blunt demand "Where's the candy"?

It is a story of vested rights. The children get so they expect the candy regardless of good behavior or any other condition.

Independent telephone manufacturers began life on the crest of a high wave of prosperity. The crest of this wave was the highest ever recorded and it is likely to stand as a record for some years.

Every wave strikes the shore eventually, however high it is, and wherever it is. Our wave struck the beach and we are all a little bit shaken and confused.

But we have no right to blame the independent telephone business for this. They have a shore line, too, and they are confused possibly, too, from the bump.

But it is darkest just before dawn. At that moment the luckless invalid is at the lowest ebb of vitality and death is nearest. At that moment, our courage is weakest and we are most liable to get an attack of "blues."

The preacher says "in the midst of life we are in death." Let us remember, that in the midst of prosperity we are in adversity. Then we will not expect the candy all the time.

In 1906 the panic cancer began. We were so busy and full of hope and life that the pain of the cancer was msitaken for a temporary attack of gastritis—as it were. Companies were beginning to ask for more time and a scarcity of money sent out its first alarm. It was not needed.

In July, 1906, the sale of development bonds practically stopped, but there was apparently enough cash on hand, and the work went on merrily.

In July, 1907, work began to stop. Orders were not placed. Men were quietly laid off. But there had been so much business that people forgot that it comes from earth and not from mental skies.

The cancer was growing, and the patient decided that the pain was not of temporary nature. So he went to the physician for treatment. From July to October the doctor guessed at the nature of the disease. Finally he realized the extent of the malady, and he operated.

The banker is the doctor of my story; and in October he discovered the cancer of "strained credit," and he began to prepare for the operation. One day he closed the bank doors and issued clearing-house certificates.

Of course, the patient did not die. He made a game fight. The headway was slow. The clearing-house certificates were the bulletins of recovery.

When the certificates began to disappear, we knew the patient was better. Finally, when the banks called in the certificates we knew the patient had been discharged as cured.

But the patient had been very sick. He had not been at work for a long time. He had to recuperate his strength. So he left the hospital and sat in the sunlight of confidence, waiting for his blood to rejoice once more through his veins. He is working now, but will likely never be as good a man as he was.

The banker is the doctor in care of our financial and industrial health. He really appointed himself. He overappreciates his importance, but we have grown accustomed to it and accept his superior qualities with resignation.

The bank is a non-productive department. It costs money to run it, but we are trained to need it, and take whatever crumbs are dropped from its table.

Caste seems to be strongly attached to banking institutions. The country banker timidly approaches the Kansas City banker, for instance. The Kansas City banker trembles at the office door of the Chicago banker, and you may be sure that the Chicago banker is not confident the New York banker will talk to him the day he arrives.

Yet the smaller banker would rather loan the money to a larger banker, because he can get it back on demand. The local depositor, wanting to build a home or a telephone plant, is not as welcome as he should be.

But when the banks got into trouble, they appealed to the pride and patriotism of the local depositor, to withhold all requests for money on deposit. In fact, if patriotism did not work, they threatened him. Consequently, not caring to draw on the funds of the bank, he withheld his orders.

A manufacturing plant has to have orders. So they shut down Fridays and Saturdays and waited.

The telephone operator waited, and he learned some lessons. He found that he could get along without rapid expansion. He found that his principal occupation was operating and maintaining a telephone plant, instead of being a purchasing agent for one.

The manufacturer, riding on the crest of the wave, did not see the breakers along the shore. He moved to more commodious quarters because he had a fool notion that he was turning away business. He paid higher rent. Instead of thousands, his expenses became ten thousands. Finally he had the satisfaction of canceling his orders for machinery.

The operator, realizing that operation and maintenance was his duty, learned some good lessons in apparatus and equipment values, and the day of shoddy apparatus and imitation woodwork was over.

The entrance of the Western Electric Company into the field of sales has been a disturbing factor to some manufacturers. Not to all, however.

This company has the advantage of being assisted by the operating forces of the Bell companies. Their agents are taking advantage of rural discontent and are encouraging mutual telephone companies.

But these same complaining manufacturers have been making a specialty of stirring up mutual trouble

and discontent. They are the companies who now have to worry about the Western Electric Company. They are worrying, too. They are paying the penalty of treachery to independent telephone interests.

These worrying manufacturers did not keep up to the independent standard and trained up a lot of undiscriminating buyers who give no thought to inferiority of apparatus. A new competitor comes along with as good a line of goods and gets the business.

Another cause of worry is the purchase of independent plants by Bell interests. One company lost 80 good customers in one state inside of a year by this method. Strange to say, 100 new and better customers have been found in this same territory.

We should rejoice that the buying-out plan continues. This means the destruction of a lot of apparatus which would ordinarily bob up and vex us, when negotiations for a new board are on.

Another thing, manufacturers are foolish anyway. I have seen 14 salesmen camping on a $1,400 job and their total expense reached $900.

Independent telephone operators are still sound. One manufacturing house has sold over $18,000,000 worth of goods since its organization, and its total losses have not exceeded $16,000, and part of this $16,000 was lost in large plants, the result of some shady work. Natural enough—however.

Cheer up, disheartened independent manufacturer, you don't realize the blessings ahead.

* * *

Coming events cast their shadows before. When I heard Jim Shoemaker read his excellent paper at Des Moines, I had a mysterious feeling that something had given him a change of heart. I did not suspect just what it was. But the paper was for the purpose of paving the way of justification for the sale of the property to the Bell interests—and it was a good paper, too.

The independent interests have lost a good man, but the telephone business still has him. The reason the Waterloo interests sold out is the old reason—money.

Adam sold out his interests in Eden for a bite of apple. Esau sold his birthright for a mess of pottage. A little later Judas got into the game and sold out the Nazarene for twenty pieces of silver. So it was Judas who created the present day "getting the money."

There are many amusing things connected with this telephone game. The louder a man talks about the steadfastness of his cause, the quicker he is to listen to a proposition from the enemy. Human nature is an old institution. The human being who talks impulsively will act impulsively, too. Blood is thicker than water—but money is thicker than blood. You have noticed how relatives fight over wills.

Some years ago, two very prominent Kansas operators made a special journey to the Chicago Interstate Convention to annihilate one Fred DeLand for building a toll line from Kansas City to Topeka with the intention of selling out to the Bell.

Three months later these gentlemen sold their plants to the Bell and accepted operating jobs. Why? They got the money.

One very prominent independent manufacturer raised a painful howl about the Kellogg company selling a few things to the Bell company at San Francisco. The salesman of the company wrote an indignant letter which was published in the editorial column of one of the trade papers.

Soon after, this same virtuous manufacturer had a chance to sell a large plant in Iowa to the Bell interests. The bidding was vigorous, and the directors of this company saw prices never before handed out.

To help out, we had the pleasure of seeing a real independent manufacturer take the general manager of the Iowa Bell on a very pleasant and expensive junketing trip. I tell you, he enjoyed the independent hospitality, and I will bet further that "Mac" laughed away down in his boots, too.

All in all, it was a grand success. In remonstrating with one of the salesmen about the sale, he said, "Well, we got the money." Well, Adam got the apple and Esau got the pottage, and Judas got the money. What kick has anybody coming?

Long ago, I asked a prominent politician high in Mark Hanna's favor, if he really believed all the bunk about hard times and Democrats being bed fellows. He said "Of course not, but we want the people to believe it." The moral is, Mr. Independent Telephone Man, you are expected to have all the patriotism.

When the National Convention met in 1906, the anti-Kellogg resolutions were enacted by a faithful lot of manufacturers. Of course, operators' services had to be enlisted. When it came to hunting a father for the infant, they had a hard time, because all the prominent men had past due accounts at the Kellogg plant. Only one man had the courage to father the resolution. So it passed. We are all glad of it. It undoubtedly helped the trial judge to get a clearer vision of the case. No hard feelings, you may be sure.

And further, the advertising feature was most humorous of all. Loyal independent manufacturers advertised side by side with the Bell interests in all other papers but telephone papers.

The Kellogg company took five shares of Electrical Show stock, when it was an infant. When the show became a success, the loyal independent manufacturers, who worked two days with us to take the stock, came over and tried to bluff us to sell, because we were a Bell-owned concern. Yet the Western Electric Company and Chicago Telephone Company were principal participants. I often wonder if Western had then been selling to the open field, what the behavior of the patriots would have been? Consistency was far away those days.

Do you wonder that the intelligent operator is inclined to be disgusted with the truth-bearing propensity of telephone manufacturers? Do you wonder that room has been made for a dangerous competitor? Do you wonder, when the Bell company goes to a group of men totally disgusted with various inconsistencies, and offers them $1.10 on every dollar they have in the proposition, that they consider the offer?

And there's another phase of the situation. You have a company, for instance, threatened with mutual invasion, and the Bell interests helping the mutuals with copper lines to the larger points. You appeal to the big city interests to help you do something. They tell you to stand pat, and to fight it out, but give you no material assistance. But you are losing ground. The Bell offers to withdraw from the mutuals and connect with you. At least the financial world does not wonder that you yield. You have money at stake.

It all depends, in this world, upon whose ax is gored.

Knowing the human nature involved, are the manufacturers going to give no heed to the shadows of coming events? The buyers are beating the life out of the seller, and on top another enemy has appeared which cares naught for profits. They are happy as long as we do not make any money.

The shadows show that there is a whirlwind to reap because the wind of selfishness has been sown. A man outwalks a dog because the dog does so many foolish chases after birds and rabbits.

The manufacturer chased the phantom of Bell ownership and other fatuous things, and now he wonders what makes him so tired.

Moral: Don't blame Shoemaker.

Sending Pictures by Wireless

By Alfred Gradenwitz

THE telegraphic transmission of handwriting, drawings and photographs is engaging the attention of scientific men in various parts of the world. In addition to the well-known method devised by Korn, several others of equal promise are being put forward and interesting results may soon be expected.

A method of wireless transmission of pictures and manuscripts has been laid before the Royal Academy of Barcelona by J. G. de Guillen-Garcia and is briefly described below:

In wireless, as in ordinary transmission, a distinction must be made between manuscripts and drawings, on the one hand, and photographs, on the other. In either case, however, the sending and receiving apparatus includes cylinders which rotate synchronously in contact with styles moving uniformly in straight lines and therefore tracing helices on the cylinders.

The style and cylinder of the sending station are connected in series with a battery and a relay, by which the circuit in which the aerial waves are generated is opened and closed, and the style of the receiving station takes the place of the style of the Morse instrument used in wireless telegraphy, and traces lines of length proportional to the duration of the train of waves.

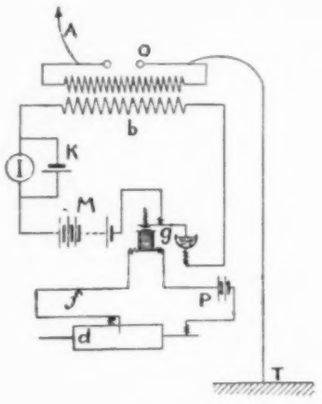
The sending apparatus for manuscripts and drawings is indicated by Fig. 1, the sending apparatus for photographs by Fig. 3, and the common receiving apparatus for manuscripts, drawings and photographs by Fig. 2.

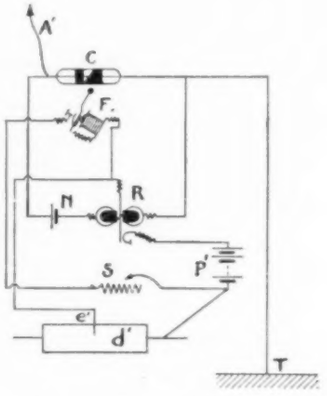
At the sending station (Figs. 1 and 3) the circuit includes the rotating cylinder *d*, style *e*, battery *P* and relay *g*. The relay is so arranged that it closes the circuit of the coil or transformer *b* and thus gives rise to sparks in the spark gap *o*, and hence to Hertzian waves, when the circuit *f* is open and no current passes through the style and cylinder.

Manuscripts and drawings are copied in a thick insulating ink on the surface of the metal cylinder, so that the passage of each line beneath the style opens the circuit, and consequently, through the operation of the relay, closes the spark circuit and causes aerial waves to be emitted by the antenna *A* (Fig. 1).

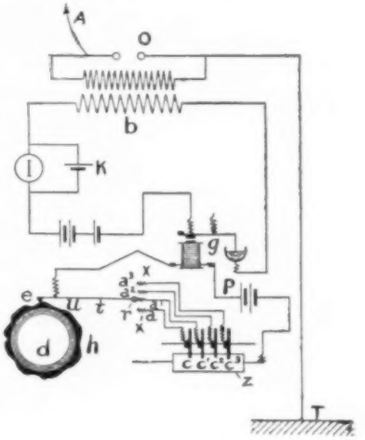
At the receiving station (Fig. 2) the aerial waves received by the antenna *A'* effect the closure of a local circuit through the battery *P'*, style *c'* and cylinder *d'*. The style is made of steel and the cylinder is covered with paper which is moistened with a solution of potassium ferrocyanide. This solution is decomposed by the current and the style traces a blue line during the passage of the current. The length of this blue line is proportional to the time during which aerial waves are sent and received and is exactly equal to the effective width of the insulating line of the drawing which, by its passage under the style of the sending station, caused those waves to be generated, provided that the two cylinders are accurately synchronized and are of equal dimensions. The result is that the original drawing or writing is reproduced at the receiving station in short, parallel blue lines, 1/20 inch apart, which distance represents the pitch of the helix.

The design can be transmitted on an enlarged or a reduced scale by making the diameter and pitch of the





Transmitter for Manuscripts and Drawings. Receiver for Photographs, Drawings or Manuscripts.



Transmitter for Photographs.

receiving cylinder larger or smaller than those of the sending cylinder. Other solutions may be substituted for the potassium ferrocyanide, or the design may be drawn mechanically instead of chemically, by the addition of an electro-magnet which will press the writing point on the paper during the passage of the current. The cylinders may also, as in the gramophone, be replaced by disks, over which the points move in spiral lines.

For the transmission of a photograph, a relief or photogravure print, either positive or negative, is made in bichromated gelatine or similar material, and applied to the surface of the sending cylinder *d* (Fig. 3). (In this diagram the cylinder is shown in cross section and the elevations and depressions of the gelatine film are greatly exaggerated.) The style *e* is attached to one end of the lever *t*, which is pivoted at *u*, and bears at its other end a small wheel *r*. As the cylinder revolves the style alternately sinks into the depressions and is raised by the elevations of the print, causing the other end of the lever to rise and fall and the wheel *r* to roll over a series of constant pieces. The contacts $x\ x^1$, at each end of the series, are of non-conducting material, while the intermediate contacts, $a\ a^1\ a^2\ a^3$, are of metal and are connected by wires with an equal number of metallic disks, $c\ c^1\ c^2\ c^3$. These disks are mounted rigidly on an insulating shaft which rotates with uniform velocity. The edge of the first disk is smooth, while those of the others show indentations and elevations, uniformly spaced on any one disk, but varying from disk to disk in such a manner that the aggregate length of the elevated portions diminishes progressively from the second disk, c^1 to the last c^3. As the disks turn, their elevavations come into contact with a metallic cylinder *z*, which turns at the same rate. One pole of the battery *P* is connected to this cylinder *z*, the other to the lever *t*. As this lever rises, falls, or remains motionless, according to the variations in the thickness of the relief print passing under the style *e*, the wheel *r* touches one or another of the contact pieces and closes the circuit, intermittently, through the corresponding indented disk and the cylinder *z*, the degree of intermittence being determined by the character of the indentation and the first wheel producing a continuous current. As the current in this circuit controls the sparking circuit, by means of the relay *g*, series of sparks and of aerial waves of varied intermittence are generated and these aerial waves cause the style at the receiving station to trace a broken line of a varying width determined by the thickness of the part of the print that is passing under the sending style. As this thickness varies with the light and shade of the various parts of the picture the result is a half-tone reproduction similar in character and effect to the ordinary "process" print. And it is evident that the relief print, whether positive or negative, can be made to yield either a positive or a negative copy at the receiving station by changing the order of the disks $c\ c^1\ c^2\ c^3$ at the sending station.—*Revue des Sciences.*

Electioneering by Telephone

Electioneering by telephone was a distinctive feature of Chicago's recent judicial campaign. Not that its use as a medium for securing votes was an innovation of the day, for other campaigns have heard its merry tinkle in years gone by, but on this occasion it was brought into play on such a large scale that it would seem to bid fair to be an established adjunct. The vice-president and treasurer of a large mercantile house is credited with having formulated the plan for the use of this mechanical lobbyist in the campaign of one judge.

This was the system:

A vast army of operators, operating 100 switchboards and some 10,000 telephones, were furnished with long lists of voters and verbal instructions to call each one up between 6 and 8 a. m. When one answered the ring he was to be handed the following:

"Don't forget to vote for Judge Blank before you go to work this morning."

The question whether the telephone idea would actually gain votes for his candidate was answered by the originator of the scheme as follows:

"Possibly it is true that some persons would be angry at being awakened and asked to vote a certain way, but we are standing by the law of averages and believe that the great majority of voters thus called will be glad of the reminder. There are only a few who would be angry. Our lists have been in preparation for three or four weeks and contain the names of all citizens who have been mentioned as friends of Judge Blank as favorable to him or as, for any reason, likely to vote for him, and I believe by this telephone system we reached from 12,000 to 15,000 people."

Some of the big business houses of the city allowed the use of their switchboards to friends of candidates for this purpose and campaign managers believe the entire experiment to be the biggest attempt of the kind ever seen in Chicago.

Panama Telephone and Telegraph Lines

At a meeting of the Isthmian Canal Commission at Culebra April 24 the chairman presented the report submitted by the committee appointed to consider questions connected with the ownership, operation and maintenance of the telegraph and telephone lines belonging to the Isthmian Canal Commission and the Panama Railroad Company. In accordance with the committee's recommendation the following agreement between the Isthmian Canal Commission and the Panama Railroad Company was approved:

On and after May 1, 1909, the Panama Railroad Company will construct, maintain and operate all telegraph and telephone lines and equipment that may be needed in the work of the said company and of the Isthmian Canal Commission; that said company will furnish to the Isthmian Canal Commission all such telegraph and telephone service and facilities as the commission may require, and as may be requested by officers of the commission with the approval of the chairman and the chief engineer.

In consideration of this agreement on the part of the Panama Railroad Company, the commission agrees to pay to said company, monthly, an amount equal to $7.50 for each telephone instrument used during the preceding month or fraction thereof, and the commission further agrees that the Panama Railroad Company shall on and after May 1, 1909, have the use without charge, of the commission's part of the telegraph and telephone plant and equipment then owned by the commission, and shall not be liable for deterioration or necessary changes or destruction thereof; and that on the termination of this agreement the railroad company shall pay to the commission the value at that time, then to be agreed on, of the commission's interest on May 1, 1909, in the plant and equipment which is turned over to the company on said date.

The commission also agrees to pay to the railroad company the sum of $2,400 per month in full payment for all services rendered by the company in maintaining extra operators, signalmen, and other employes made necessary by the operation of I. C. C. trains over the railroad company's tracks. The commission will pay telegraph operators in its own offices as heretofore.

Who's Who in the Telephone Game

Facts and Fancies About a Man You Know or Ought to Know

JUDGED by its name alone, you would expect very little attraction from the Toughkenamon valley, no matter where it was. Bayard Taylor traveled all over both hemispheres before he settled down permanently in what he declared to be the most beautiful valley in all the world. It was the Toughkenamon. He acquired a large estate and built his famous castle, Cedercroft, at Kennett Square, Pennsylvania, a town that was plotted to obtain the best perpetual view of the Toughkenamon valley. All the citizens pay homage to Bayard Taylor's good judgment—his conception of the beautiful. The town was peopled with Dunkards and Quakers, in an earlier day, and the traditions of these extremely pious folk have always lingered about the place. It is about thirty miles west of Philadelphia, in Chester county, and has a present population of 1,200.

It was Stevenson who said, "Men who are in any way typical of a stage of progress may be compared more justly to the hand upon the dial of a clock, which continues to advance as it indicates, than to the stationary milestone, which is only the measure of what is past. The movement is not arrested."

During the period of Germany's internecine strife, eighteenth century, a colony of devout Baptists, because they refused to take up arms, were banished from the empire. These extremely religious people emigrated to America and settled in southeastern Pennsylvania. They were Dunkards.

Very Little Imagination is Needed to See the Quaker in Him.

Dunkards were German Quakers. Quaker atmosphere suppresses all imagination and emotion. Dunkard environment nearly kills it. Only a little while ago the Dunkards of northern Indiana put the taboo on telephones as an instrument of the devil. You would presume that Stevenson had overlooked the Dunkard as marking any stage of progress in the scheme of things, but Dunkards have some fixed notions about religion that may alter your opinion. They condemn war and litigation, presumably because they were driven from Germany. Most of them came to Pennsylvania, and having an eye for the real beauties of nature, many of them stopped in the Toughkenamon. They brought their religion with them. It exacts feet washing before partaking of the Lord's supper. Baptism isn't supposed to "take" until after the third immersion. It's a triple-plated process.

Joseph Jackson was directly descended from these stalwart, determined people. He lived on the old Jackson Homestead, three miles out of Kennett Square, when his children were born. He kept them there until it was essential that better educational advantages be had. Himself an instructor, he accepted a professorship of mathematics at State College in 1881, a position he retained until 1893. His children were all graduates of State College. There were four of these children, three boys and a girl.

Dugald Caleb Jackson was the first born in 1865. He was sixteen when he began his college life and he has been continuously at it ever since. Let's see, that would be twenty-eight years at school. Well, some people must like it, that all! In the old class of '85 there were nine graduates and D. C. had the honors. This same old college graduates 150 a year nowadays. Cummings C. Chesney, first vice-president of the Pittsfield works, General Electric Company, was a Jackson classmate. Old State College was turning out sturdy men after the then approved plan—three immersions to make it stick—a triple-plating.

Horace Greeley's "go west" caught young Jackson and he joined J. S. White in the old Western Engineering Company that was active in pioneer electric railway and electric light work. Most of the operations were in Nebraska. The company designed, constructed and operated many splendid plants and systems.

Dugald Caleb Jackson has been a professor of electrical engineering, as well as a consulting electrical engineer since 1891. He resigned a place at the head of the department of electrical engineering, University of Wisconsin, to accept a like position with "Boston Tech"—Massachusetts Institute of Technology—his present occupation. He is a brilliant example of Stevenson's illustration of men who typify progress. His mind is analytical—his mastery of difficult problems, a chief delight.

In telephone work Mr. Jackson is specializing on studies with respect to service, rates and rate regulation. His reports usually take this form: two per cent preface, ninety-seven per cent statistical tabulations, one per cent recommendations, and a bill. Heading a special commission with William H. Crumb and George W. Wilder, his report on the "Telephone Situation in the City of Chicago," April, 1907, easily became the most important commercial contribution that had to do with large telephone interests. More recently he has had a similar assignment, acting for the Massachusetts Highway Commission. Something of the magnitude and cost of this

work has been mentioned in this magazine. D. C. Jackson shows his Quaker stock. He looks it. Very little imagination is needed to see the Quaker in him. Given a broad-brimmed, flat-crowned felt hat, a Prince Albert coat, and a Fra Elbertus cravat, he would have all the "props" necessary to wipe out the progress of the clock hand. The indomitable courage of his ancestors is reflected in the things that he does. The educational training of his parents, combined with his own studious tendencies, makes him an instructor of high degree.

Mr. Jackson lives in Brookline, Mass. He is married and has a son and daughter. He is a member of the New York and Chicago Electrical Clubs, the Milwaukee Club, Milwaukee; the Union League Club, Chicago, and the St. Botolph Club and City Club, Boston.

His brother, Wm. B. Jackson, is associated with him in business. The firm has offices in Boston and in Chicago.

Court Denies Writ of New York Company

The Appellate Division of the Supreme Court of New York denied the appeal of the New York Independent Telephone Company from an order denying a writ of mandamus directing the commissioner of water supply, gas and electricity to issue to the company a permit to lay wires.

Justice Clarke, who wrote the decision, says that the New York Independent Telephone Company was merged with the Mercantile Electric Company in 1905 and now claims the right to lay wires under the franchise of a concern organized for a burglar alarm business.

"What is directly involved is the right to place an additional cable 225 feet long in a duct occupied since 1894," says the court. "What is indirectly involved is whether a burglar alarm company operating in a very limited territory in the financial district, which has been transformed into a general telephone company possessing a franchise entitling it to occupy any and every street in Greater New York and extending over the whole of Mexico, the United States and Canada, possesses without payment to the city of New York rights so extensive and valuable that for such privilege another company offered to pay $2,780,000."

The court finds that the company having the original franchise never applied for permission to lay wires.

A Telephone Exchange on Board Train

The complete utility of the telephone on moving trains was fully demonstrated on the special train of the California Promotion Committee, which carried one hundred Californians to the Alaska-Yukon-Pacific Exposition. The train, composed of seven sleepers, two diners, one composite, one observation and one dynamo car, left San Francisco Saturday evening, June 12, returning Sunday morning, June 20. During its absence from San Francisco it was the home of the hundred men, being run on the plan of a first-class social club.

The train was equipped with wireless telegraph and messages were sent and received at all times en route and while in Seattle, this being the first complete train to be so equipped.

The utility of telephone service on trains, however, was the most essential feature. A switchboard, with relays of operators day and night, was installed and every car on the train connected and supplied with telephones. This service, the installation of which by the Pacific Telephone and Telegraph Company cost more than a thousand dollars, was thought of only as a novelty at first; but the train had not proceeded twenty miles before its practical utility was recognized.

At each telephone throughout the train was a list of those on board with their car and section number, and it was only necessary to notify the operator that an individual was desired and connection was quickly made and

Telephone Exchange on a Railroad Train.

conversation carried on as easily as from house to house in a city. When it is considered that the train was three city blocks in length it will be realized that the telephone was from the start a great convenience.

On arrival at Seattle, Tacoma and Portland, connection was made with the local exchanges through four trunk lines, and local and long distance communication established, much to the convenience of the people on the train as well as to the expediting of business matters connected with the various functions of the party. The exchange was in charge of Messrs. James G. Leckner and A. G. Green, and during the entire trip they rendered complete service.

An American consul in the Levant reports that tenders for a telephone system are invited by a large city in his district. This is an important enterprise, and includes telephone connections with the neighboring cities. The time limit for receiving tenders is September 30, 1909. The file number at the Bureau of Manufactures, Washington, D. C., is 3634.

Principles of Fault Location

By Julius Bernstein*

IN presenting this paper on fault location my remarks, which are based upon the methods of telephone practice, will be confined to the use of those testing instruments which are based upon the principle of the Wheatstone bridge, inasmuch as practically all faults can be located by the "loop" methods, which are particular cases of the Wheatstone bridge.

WHEATSTONE BRIDGE.

The system of conductors called the Wheatstone bridge is the most common of the several arrangements for measuring resistances, and is represented by the familiar conventional diagram shown in Fig. 1. The current from the battery is made to branch into two paths at c and unite at d, so that part of the current flows through the points e and f. A, B, X, and R, are known as the arms of the bridge, although in practice A and B are termed the "bridge arms" or "ratio arms," R, the "rheostat," and X the "unknown resistance." When the galvanometer shows no deflection, it becomes evident that the two points e and f are at equi-potential; since current flow can only be the result of potential difference.

The bridge is said to be balanced, and the resistances in the arms will then have relation to each other as expressed in the simple proportion:

$$\frac{A}{B} = \frac{X}{R} \text{ or } A \times R = B \times X.$$

From the foregoing simple proportions, it is apparent that, by knowing the values of three arms of the bridge, the fourth can be quickly calculated, or

$$X = \frac{A}{A} R$$

It is to be noted that any resistances in the galvanometer r or battery r' circuits do not affect the values or ratios or the bridge arms. It is also to be noted that

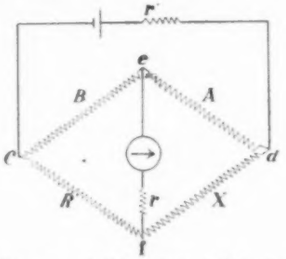


Fig. 1. Diagram of Wheatstone Bridge Connections.

the position of the galvanometer and battery may be interchanged without in any way affecting the law of the bridge.

The Wheatstone bridge would have a restricted range of measurement if the arms were equal. It will be evident that the adjustable resistance will represent the total amount of the unknown resistance that can be measured under conditions of equal bridge arms. By altering the ratio of the arms of the bridge we can measure very high or very low resistances. This is accomplished in an actual bridge by placing in the arms A and B resistances having values of at least 1, 10, 100, 1,000 ohms, and at times 10,000 ohms.

If the unknown resistance is equal to the ratio $\frac{A}{B}$ multiplied by the resistance in the rheostat to balance,

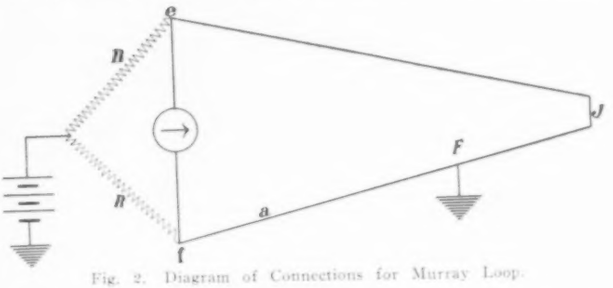


Fig. 2. Diagram of Connections for Murray Loop.

it is evident that when measuring small resistances, maximum accuracy will be had by making A small and B large, as this will mean a division for the value of the rheostat. If, for instance, we make A 1 ohm, and B 1,000 ohms, and the rheostat value was 67, the unknown resistance would be 0.067 ohm. If we were concerned with measuring a large resistance, we would place a larger value in A and a small one in B. If A were made 1,000 ohms, and B 1 ohm, and the rheostat value was 67, the unknown resistance would be 67,000 ohms.

Having thus familiarized ourselves with the basic principles of the Wheatstone bridge, we will turn our attention to a modification of the Wheatstone bridge, called the slide-wire bridge.

Referring again to Fig. 1, we can reason that it is not necessary to know the actual values of the resistances in arms A and B to determine X, if we know their ratio. Our assumption is that when the bridge is balanced, the voltage drop over A equals that over X, and the drop over B equals that over R, consequently if the parts A and B consist of a straight wire with provision so that one terminal of the galvanometer can be moved along it for a balance, then the proportional parts of the wire on each side of the balance point can be used for the ratio $\frac{A}{B}$.

It can be looked upon as being a Wheatstone bridge, in which the bridge arms are varied to obtain a balance, and the rheostat has one fixed value for any particular measurement. Since the value of the unknown resistance is determined in terms of the rheostat by the ratio of the bridge arms to each other, it is immaterial whether we express the ratio in ohms, or in length of wire.

TESTING SETS.

The term "portable testing set" is usually understood to mean some form of Wheatstone bridge, complete with galvanometer and battery, mounted in a carrying case, and arranged for the various tests to which a bridge can be put. There are two types in general use,

*Abstract of paper read at the convention of Municipal Electricians.

namely, the plug and dial. In the plug type the resistances are inserted in the circuit by manipulating plugs, and in the latter switches or dials are utilized.

CLASSES OF FAULTS.

Before considering any diagrams, some general remarks will be in order. The term fault is intended to cover every variety of damage by which the electrical efficiency of a line is affected. Defects which impair the mechanical condition of the line, without affecting it electrically, do not come under the heading. An aerial wire may be penetrated by rust, or a cable sheath may be damaged, without a trace of change in the electrical condition of the line.

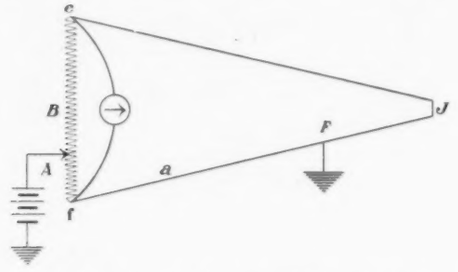


Fig. 3. Circuit Similar to Slide-Wire Bridge.

The different kinds of faults may be distinguished by the following classification:

Grounds are defective insulation, to ground or to a cable sheath.

Crosses are defective insulation between wires.

Opens are breaks in the conductor, so that two parts are entirely separated electrically.

Inductive crosses result from the transposition of single sides of adjacent pairs.

In speaking of crosses or grounds, it is well to use the modifiers "total" or "dead" and "partial," as a dead ground and a partial cross.

The first step in fault testing is to ascertain the nature of the fault and to give some particular study to the line in trouble by reviewing your knowledge of the line conditions. Having decided whether it is an open, a cross, or a ground, the next procedure is to make a location. The Wheatstone bridge is employed for locating a cross or ground by the "loop tests," and so called because it is necessary to have a complete circuit from one binding post of the instrument through the faulty section of the line and back to the other binding post of the instrument. The circuit is called the loop. The different sections forming the loop need not be of the same sectional area; it is only necessary that there be two independent paths of good insulation from the testing point to the fault. The simplest way to get this loop is to use the mate of the faulty wire, if the wires are in a cable; or, if the wire is an aerial or single conductor in a cable, then we must use an external conductor for a return.

THE MURRAY LOOP TEST.

Referring now to Fig. 2, which represents the connections for the Murray loop, at first inspection we will see an arrangement of conductors exactly like that of the Wheatstone bridge. The wire $f\ T$ has a fault at F, and is looped to a good wire at J. The loop is connected to the testing set at e and f. The resistances B and R are in the instrument, and form two arms of the bridge, while the section $f\ F$ of the faulty wire, and the remaining portion of the loop $F\ e$, form the other two arms of the bridge. The galvanometer and battery are connected as shown. The current from the battery flows through the earth from the point of grounding at the testing set to the fault. This connection is independent of the resistances forming the bridge, as far as its own resistance is concerned. The earth has a negligible resistance, and while the fault will generally have some resistance, unless it be a dead ground or cross, its resistance corresponds to r' of Fig. 1. Calling a the resistance of the wire from f to F, or the resistance from the instrument to the fault, and r the total resistance of the loop, from the law of the Wheatstone bridge we have:

$$\frac{B}{R} = \frac{r-a}{a} \text{ and } a = \frac{Rr}{B+R}$$

From the last equation, the distance to the fault may be readily calculated when the values of B and R and the resistances per unit length of the loop wires are known.

Since in uniform wires the resistance is proportional to the length, these equations may also be written, when all the wire of the loop is of one size:

$$\frac{B}{R} = \frac{L-d}{d} \text{ and } d = \frac{RL}{B+R}$$

where L is the total length of the loop, and d is the distance to the fault. This formula should always be used when it is applicable, as it is the most accurate as well as the most convenient. In using the previous formula, in order to calculate the distance to the fault, the resistance of the wire per 1,000 feet must be determined from a wire table. A slight variation from gage or a difference of temperature from that assumed may cause a considerable error. Errors from these sources are very largely eliminated when the distance to the fault is determined as a fraction of the length of the loop.

In using a bridge for locating by the Murray loop, it is customary to use a 10,000-ohm coil for arm B, and vary the rheostat until a balance is obtained. This operation, while quite simple, can be made more rapid when using testing sets built upon the slide-wire principle. In using an instrument of this kind, there are limitations in its range, but in its own field of usefulness it is to be strongly recommended.

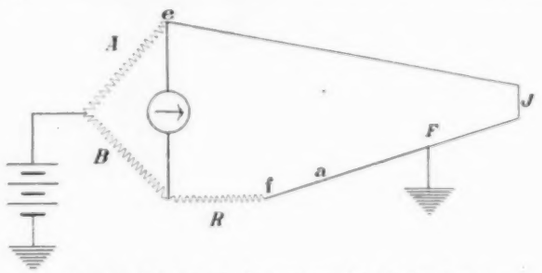


Fig. 4. Diagram of Connections for Varley Loop.

Referring to Fig. 3, a circuit will be noted arranged similar to that of the slide-wire bridge. A contact can be moved along a uniform resistance, and the ratio is that of the two parts of wire on each side of the contact. Let r equal the total resistance of the loop, and a the resist-

ance from the instrument to the fault, then the formula for solving becomes quite simple, and is:

$$\frac{A}{B} = \frac{a}{r-a} \text{ from which } a = \frac{Ar}{1{,}000}$$

Another way of analyzing this case is to note the symmetry of the arrangement as indicated in Fig. 3.

It is apparent that if the bridge is balanced with the contact half way between *e* and *f*, then the arm *f J* must equal *e J*, since *A* and *B* are equal, which implies from the law of the bridge that the other two arms must have the same ratio to each other. As the arm *B* increases and *A* decreases, so does the distance or resistance from *e* to *F* increase, and the distance or resistance *f F* decrease. Since in uniform wires the resistance is proportional to the length, this formula may be written:

$$\frac{A}{1{,}000-A} = \frac{d}{L-d} \text{ and } d = \frac{A}{1{,}000} L$$

where *L* is the total length of the loop, and *d* is the distance to the fault from *f*. The last formula is the most convenient, but it is only applicable when the wires have the same resistance per unit length.

THE VARLEY LOOP TEST.

The Varley loop test differs from the Murray in having a portion of the loop made up of resistance in the testing set, as shown in Fig. 4. The Varley test can be most usefully applied in those types of bridges which permit of making the ratio of *A* to *B* unity, or 10, 100, 1,000, etc. In these cases the ratio of *A* to *B* is fixed and *R* is varied until a balance is effected. Calling *r* the resistance of the faulty wire *f J* plus that of the wire *e J* and *a*, the resistance from *f* to the fault, we have:

$$\frac{A}{B} = \frac{r-a}{R+a} \text{ and } a = \frac{Br-AR}{A+B}$$

The formula for the Varley loop admits of several modifications, which will not be given at this time, for lack of space.

If the fault in a grounded or crossed conductor were

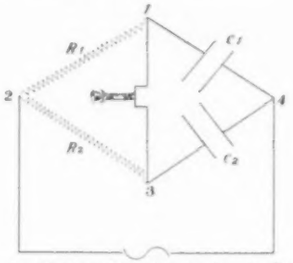


Fig. 5. Testing Capacity to Locate Break.

always of practically infinitely low resistance—that is to say, if it were a "dead" ground or short-circuit—its location could easily be detected by measuring the resistance from the point of test, and back again through the ground, or through the other conductor affected by a regular resistance test. Unfortunately, however, it is seldom the case that this condition exists, and tests giving results independent of the resistance of the return circuits and at the point of trouble are therefore necessary.

The loop tests fulfill these requirements. The only effect a high resistance will have upon our test will be to reduce the electromotive force of the battery, so that in very high resistance faults it becomes necessary to employ 50 and 100 cells, so as to impress the electromotive force through the fault, so that the galvanometer will have sufficient sensibility.

THE LOCATION OF OPENS.

When a conductor is actually broken and there is no return circuit from the break, a new set of conditions must be considered. In locating the break, we depend upon the fact that every conductor, whether it is in a

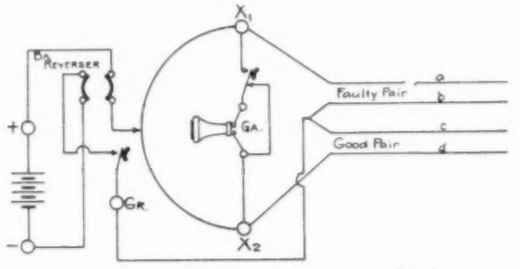


Fig. 6. Testing Capacity with Telephone Receiver.

cable in the earth or submerged in water, or is an air wire, possesses "capacity" and is in fact a condenser. The conductor itself forms one plate, the insulation from the point of test to the break of the dielectric, while the other plate is the earth, water or lead sheath.

This capacity is generally proportional to the length of the conductor, so if we know its capacity per unit length, and measure the capacity up to the break, we can calculate the length of the conductor to the break. This method is open to the objection that the capacity cannot always be relied upon as uniform throughout the length of the wire, variations of 10 per cent or more often occurring. In measuring the capacity by this test, the deflection method is used, in which the cable is charged to a certain potential, and the discharge is then read by means of a deflecting galvanometer. The deflection, however, is liable to be augmented through the action of what is called "electrical absorption," which produces return currents after the true discharge of the condenser capacity is over. This phenomenon takes place to greater or less extent with all cables, and increases with rise of temperature.

A method which largely removes the above objections, and at the same time can be performed by a simple bridge arrangement, with the addition of a telephone receiver and reversed battery current, is to compare the capacity of the open wire, from the point of test to the open, with the capacity of the good mate of known length.

Referring to Fig. 5, if the capacities of C_1 and C_2 (represented by the conventional symbol of parallel lines) are the capacities of an open wire and its good mate, respectively, we can balance the two capacities against R_1 and R_2 in the other two arms of a Wheatstone bridge. Instead of a galvanometer and battery, a telephone and a source of alternating current are shown in Fig. 6. When the resistances are adjusted so that no sound is heard in the telephone, then the points 1 and 3 are equal in potential. The cable capacities represented by C_1 and C_2 are then charged to the same difference of potential and contain quantities of electricity proportional to their capacities; but the quantities flowing into the condensers in the

same time are inversely proportional to the resistances R_1 and R_2; therefore,

$$\frac{R_2}{R_1} = \frac{C_1}{C_2}$$

Since the good and bad wires are under similar conditions, their lengths may be taken as proportional to their capacities. Hence, if L_1 and L_2 represent the lengths of the bad and good wires, then

$$\frac{R_2}{R_1} = \frac{L_1}{L_2} \text{ or } L_1 = \frac{R_2}{R_1} L_2$$

The question of allowance for lead wires does not enter, unless the leads are very long or a wire in a cable is used for a wire leading to the faulty cable.

In the use of testing apparatus, it is of primary importance that good electrical connections be made throughout the circuit. Attention must be paid to the cleanliness and the firm binding of all wires and leads. If, for instance, the assistant does not make a good connection in joining the good and faulty wires, but introduces a resistance of one-fourth ohm, where the wire is No. 22 B. & S. copper the location will be 16 feet in error. Proper care therefore will be immunity from many troublesome derangements and failures, the causes of which are usually discovered after much loss of time and labor.

FOREIGN CURRENTS.

A source of inconvenience and error lies in the fact that at the fault there may exist an electromotive force due in some instances to the contact potential difference between the faulty conductor and that on which it is grounded. Not infrequently stray currents are flowing on your wires from light and power circuits, or are induced from such circuits. These currents are generally irregular and cause irregular deflections of the galvanometer. Where they occur, the battery should be made as large as possible, so that the galvanometer deflections due to the test current may be larger than those due to the stray current. If this precaution does not make it possible to make sufficiently accurate location, it may be necessary to make use of another loop or postpone the test until conditions are more favorable.

A DISAPPEARING GROUND.

A disappearing ground is occasionally encountered while trying to locate a fault. This is generally caused by the battery current from the testing set turning a slight moisture ground into gas. Sometimes, by waiting for a short time, the ground will reappear. By employing more battery, so as to get a higher voltage, and taking a quick reading, it is sometimes possible to catch a location. It may be advisable in these cases to interchange the galvanometer and battery. When this is done the galvanometer current only flows through the fault, and it is much less likely to dissipate it than the battery current.

Sometimes the ground can be increased or permanently burned out by applying a ringing generator to the faulty wire. Before doing this, disconnect the testing apparatus.

If these methods are unsuccessful, it is best to leave the trouble until it becomes worse. A ground that is sufficient to make a line noisy, can, as a rule, be located.

INEQUALITIES IN LINE RESISTANCE.

All fault locations by loop methods are based on the assumption that the wires have a uniform resistance per unit length. This is never exactly true, and is sometimes very far from true. Unless the wire inequalities balance each other, which they do in many cases, the calculated location will be in error exactly in proportion to the inequalities. Among the causes of inequalities are introduced resistances such as poorly soldered sleeves, slight variations in gage, and inequalities in the temperature of different parts of the line. It is generally impossible to correct for these inequalities. In the cases of long lines, where there are considerable inequalities in temperature, the resulting resistance variations may be calculated and allowed for.

Another cause of inequality is unequal twisting of a wire in a cable. For this reason the loop should be made whenever possible by connecting the faulty wire to its mate, as the two will then be subject to the same conditions of twist, temperature, etc.

On lines where a source of trouble is suspected as being due to poor joints, it is well to measure the resistance of the line from point to point, and compare the results with the correct resistance per unit length.

CORRECTIONS FOR LEAD WIRES.

It sometimes happens that the testing instrument cannot be placed directly at the cable ends, and it then becomes necessary to employ leading wires between the testing set and cable. When such is the case, it is simplest to use the leading wires of the same size as the faulty wire. Then the length of these leads must be added to L, the combined length of the good and the bad wires, and from the calculated distance to the fault must be subtracted the length of the leading wire connected to the faulty wire. If the leading wires are different in size from the cable wires, multiply the length of each of the former by its rated resistance per 1,000 feet and divide the product by the rated resistance per 1,000 feet of the size of wire in the cable. The values thus found represent the equivalent length of cable wire having a resistance equal to each leading wire.

If the resistance of each leading wire is known the equivalent length of the faulty wire having a resistance equal to each leading wire is found by dividing their respective resistances by the rated resistance per 1,000 feet of the faulty wire, multiplying the quotient by 1,000.

Occasionally it may be necessary to employ fixed leading wires whose separate resistances are unknown. The individual resistances of the wires may be obtained most easily by connecting them at the distant end and measuring the resistance of the loop. Then ground the connection and apply either the Murray or Varley loop test. This will give the proportion of the total loop resistance in each wire.

Of importance equally as great as that of locating a fault after its occurrence, is to make systematic tests upon one's lines, so as to foretell the occurence of such defects. The use of high-class insulated wires, both for overhead and underground cables, has increased to such an extent in recent years that I feel we are not realizing the importance of making systematic tests in order to maintain as high an efficiency as we should. This necessity of testing is especially true in the case of those who have charge of so vital a system as police and fire circuits.

Consul-General Ravndal, of Beirut, states that tenders are invited for the construction of a telephone system at Beirut, including connections with the neighboring cities. Tenders are limited to September 30. Proposals should be addressed to the consul-general.

Recent Telephone Patents

By David S. Hulfish

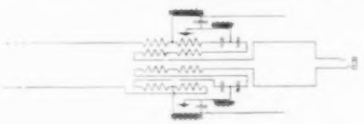
It will be the purpose of this department to list all United States patents, as they are issued, which pertain to any branch of the telephone business, giving such data in each case as will enable the reader to judge whether he wishes to see the complete drawings and specifications of the patent. When patents of special interest to TELEPHONE ENGINEER readers are encountered, the descriptive matter herein will be amplified accordingly. A complete copy of drawings, specifications and claims of any patent listed will be furnished from this office upon receipt of ten cents.

921,429. Meter System. A system having the meter at the central office and associated with the answering jack of the line, the meter being operated through the cord pair by control of the called line. Johann H. Meyer, Magdeburg, Germany.

921,894. Signaling System. A combined telephone and fire-alarm telegraph system. Edgar E. Salisbury, Chicago, Ill., assignor to Signalphone Alarm Company.

922,001. Telephone. A telephone of specific design for transmitting speech by contact with the body rather than by the vibrations of the air. Means is provided for holding the receiver at the ear of the user. Eugene Koehler, Philadelphia, Pa.

922,006. Signaling System. This patent reads from the principle of the well known Dean harmonic converter, for furnishing ringing current for harmonic telephone bells. A. D. T. Libby, Elyria, Ohio, assignor to the Dean Electric Company, of same place.



922,206.

922,045. Pay Station. A coin selecting device for telephones, arranged to have the coin close an electric circuit or a plurality of them, to give the signal. Thomas H. Roland, Huntington, W. Va., assignor of one-fifth to Abraham Twell, of same place.

922,206. Composite System. A method of taking off the telegraph tap from a composited telephone line. Henry B. Stone, Providence, R. I.

922,436. Signaling System. A system for pole changer circuit whereby the primary circuit of the pole changer does not take current except when a line is being rung upon. Ray H. Manson, Elyria, Ohio, assignor to the Dean Electric Company, of same place.

923,035. Telephone System. A specific arrangement of circuits and apparatus for a trunk line between two common battery switchboards. Alfred H. Dyson, Chicago, Ill., assignor to American Electric Telephone Company, of same place.

923,499. Signaling System. A common battery line has a battery permanently bridged, and ringers similarly bridged through condensers. The signaling means consists of a device for short-circuiting the line in rapid successive impulses, whereby the condenser discharges are permitted to actuate the ringers. Frederick S. Davenport, Atlanta, Ga.

923,499.

923,603. Telephone Attachment. In connection with a telephone set, an auxiliary receiver, electrically connected in multiple with the original receiver, whereby a receiver is had for each ear; and a hook upon the telephone set upon which the second receiver may be hung. Warren H. Taylor, Stamford, Conn.

923,637. Attachment. A face screen or voice screen for the transmitter, to make the conversation less audible in the room and more audible in the transmitter. Marcus P. Flack, New York, N. Y.

923,877. Circuit for Coin Collector. A specific circuit and arrangement of contacts at the sub-station for automatic coin collector of the well known Western Electric type. J. L. McQuarrie, Chicago, Illinois, assignor to Western Electric Company, of same place.

923,882. Attachment. A condenser and a push button switch are mounted in a single case as an accessory part to a telephone sub-station set. Richard E. Pedigo, Chariton, Iowa.

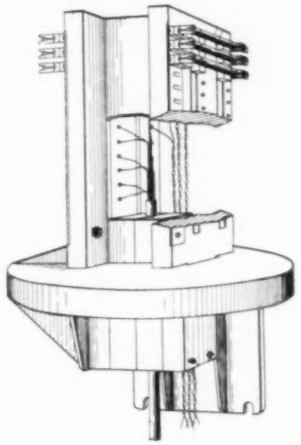
923,889. Condenser. A process of manufacture of rolled condenser. Albert Preussman, Chicago, Illinois, assignor to Western Electric Company, of same place.

923,933. Terminal Box. A distributing terminal box for pole terminal for telephone cables, including means for clamping the cable to be terminated and for providing a seal for the end of the cable. Frank J. Beaucond, New Albany, Indiana, assignor to Southern Indiana Electrical Company, of same place.

923,949. Relay. The magnetic circuit has two air gaps and two armatures to close them, the first armature operating to close the first gap to strengthen the magnetic flux in the second gap whereby a greater force is available to operate the second armature to control the contact springs. E. B. Craft, Chicago, assignor to Western Electric Company, of same place.

923,950. Attachment. A pad and a clip for holding the pad inside a transmitter mouthpiece, the pad being charged with antiseptic material. Ernest B. Crosby, Lockport, New York.

923,993. Switchboard System. A cord pair circuit including a magnetic listening key for the operator, and a signal associated with the listening key and indicating the pair or pairs of cords to which the operator's telephone set is connected. James L. McQuarrie, Oak Park, Illinois, assignor to Western Electric Company, of Chicago, Illinois.



923,933.

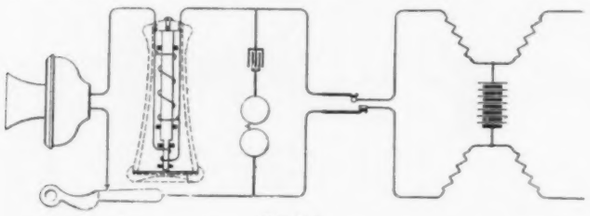
924,030. Telephone Ringer. A ringer of the tuned or harmonic variety. Jules A. Birsfield, Chicago, Illinois, assignor to Alfred Stromberg, of same place.

924,072. Attachment. An antiseptic mouthpiece for telephone transmitters. The transmitter funnel is conformed to hold a pad, which is charged with an antiseptic. Milton S. Hufschmidt, San Francisco, and Charles F. Wagner, Oakland, California, Wagner assignor to Hufschmidt.

924,573-4-5-6-7. Battery and Holder. The patents of this series contemplate the use of a battery cell with a screwthreaded top, or other convenient means of attachment, together with a holding structure adapted to receive the screw thread or other means, and to connect the batteries together and into the required circuit when the battery cells are attached to the holding structure. George L. Patterson, New York, and George H. Hopper, Brooklyn, New York, assignors to Alice C. Patterson, New York, New York.

924,714. Receiver. A receiver adapted to be connected directly into a common battery line circuit without special means for avoiding the usual undesirable effects of polarization due to

the line current. The receiver has no permanent magnet, deriving its necessary field magnetism from the line current. The receiver has two windings, one of which is adapted to magnetize the receiver from the line current, while the other takes the



924,714.

major portion of the speech currents and is effective upon the diaphragm. Ernest E. Yaxley, Chicago, Illinois, assignor to Monarch Telephone Manufacturing Company, of same place.

924,826. Battery Conductor. A flexible conductor with spring clamps upon the ends. Oliver E. Pettee, Rockland, Maine.

925,093. Dynamo. An electric generator of special construction, of the homopolar design, which will produce a smooth current suitable for applying to the telephone line directly, without intermediate devices. John L. Hall, Schenectady, New York, assignor to General Electric Company, of same place.

925,098. Lockout. A device whereby upon a party line all substations other than the one first upon the line may be locked out, and with the provision that the subscriber at the first station may make it possible for other stations to come upon the line if he so desires. R. D. Harris, J. E. Johnson and H. W. Soest, Fort Wayne, Indiana.

925,420. Disconnector. A means for disconnecting the telephone line outside of the building. Such devices are appreciated by the timid, who disconnect the telephone during electrical storms, to reduce the danger of conducting possible lightning discharges into the building over the telephone line conductor. Moses Bowman, McHenry, Maryland, assignor to Chauncey Bowman, Boynton, Pennsylvania.

925,452. Battery Holder. A supporting device and arrangement of terminals such that a series of cells and battery may be hung upon the support and thereby be connected together and into the proper circuits for which they are to be used. Seth A. Brown, Buffalo, New York.

925,573. Telephone System. A system for intercommunication or house system telephones, having a bank of keys by which each substation may call any other directly. A novelty consists in the application of the talking battery to the called line through the selecting of keys, by which the potential of the battery is kept off of the line conductors when the line is not in use. William A. Fricke, Chicago, Illinois, assignor to Monarch Telephone Manufacturing Company, of same place.

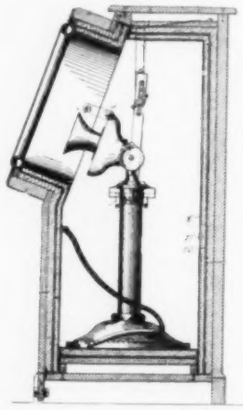
925,594. Fault Locator. An electromagnetic device for fault location in cables by detecting through the sheath a test field produced by the defective wire. Walter O. Pennell and Henry L. Hoffman, Kansas City, Missouri.

925,609. Speech-Current Relay. A novel type of relay for speech currents, of the type which comprises a microphone or variable resistance together with electromagnetic controlling means for it. Two pairs of magnets are used, and the resistance is placed between them. Harve R. Stuart, Wheeling, West Virginia.

925,756. Party Line. That one station of a party line may not shunt the others when several are upon the line at once, an obstructing resistance or equivalent is included in each bridge in series with the telephone. The primary circuits of the telephones are left open and a push button key is provided to close them, which key also shunts the impeding resistance to increase the effective transmission. George C. Cummings, Western Springs, Illinois.

925,775. Miniature Booth. This so-called booth is just large enough to contain a telephone of the portable or desk stand type, and the booth is provided with an opening closely fitting the face of the telephone user. The device is substantially a voice screen, rather than a screen for the free ear of the telephone user. Edward F. Hutton, New York, and George A. Ellis, Jr., Bay Shore, New York, assignors to The Miniature Telephone Booth Company, of New York, New York.

925,806. Miniature Booth. In connection with a miniature booth and a telephone set placed inside thereof, a hook external to the booth is provided, and means connecting to the hook lever of the telephone set whereby the hook switch is operated. Orrin H. Goodrich, Castleton Corners, New York, assignor to The Miniature Telephone Booth Company, New York, New York.



925,775.

926,175. Switch. A keyboard device for ringing upon party lines, with ringing keys which retain sufficient of their depression to identify the last depressed key from the remaining ones. Merritt S. Conner, Rochester, New York, assignor to Stromberg-Carlson Telephone Manufacturing Company, of same place.

926,199. Toll Apparatus. Lest the telephone company forget and thereby get not the patron's nickel, Mr. Larned has invented a combination of slow and fast relays whereby the subscriber's nickel is taken from the coin box position of suspense automatically when the connection is taken down by the operator. A quick-release relay connects the coin-cashing generator to the line and a slow-release relay then disconnects it from the line, all dependently upon the removal of the operator's plug from the jack. Sherwood J. Larned, Chicago, Illinois, assignor to Western Electric Company, of same place.

926,510. Party Line. A bridging, lockout, selective signal, common battery, party line, telephone system. As if that were not enough, be it known also that there is provided in this system the possibility for any locked-out station to signal to the central office that a connection is desired, and without interrupting the conversation then in progress upon the line. It took three inventors to turn the trick, one of them imported. Homer J. Roberts, Evanston, Illinois, Cyril A. Soans, formerly of England and now of Chicago, Illinois, and Albert H. Graves, of Chicago, Illinois, assignors to Homer Roberts Telephone Company, of Chicago.

Valuation of Indiana Telephone Properties

The annual report of the Indiana State Tax Board, just issued, shows a total telephone property valuation in the state of $10,201,519, as against $10,572,987 for 1908. These companies are taxed on the valuation of their corporate property, the assessments being made on reports to the board during the month of May each year. There is considerable speculation over the fact that the chief decreases were made in the property of the Central Union Telephone Company and the Cumberland Telephone Company, both Bell concerns, and that conspicuous increases occur in the values of the independent telephone properties. The Indianapolis (independent) Telephone Company's property is valued at $79,000 and the New Long-Distance (independent) Telephone Company's property at $41,000, more than last year. The only increase in valuation assessed against the Bell property was $5,873 against the American Telephone Company and the only decrease of any material amount given to an independent company was $20,480 in favor of the Citizens Telephone Company, of Fort Wayne, due to loss by storm.

Of Interest to the Trade

A New Line of Central-Office Switchboards

The Western Electric Company is offering to the trade a complete line of non-multiple central-office switchboards, known as the No. 1200 series. These switchboards are made up in one and two-position sections, each type of section having three different capacities, as for example: 60, 105 and 165 lines to a position.

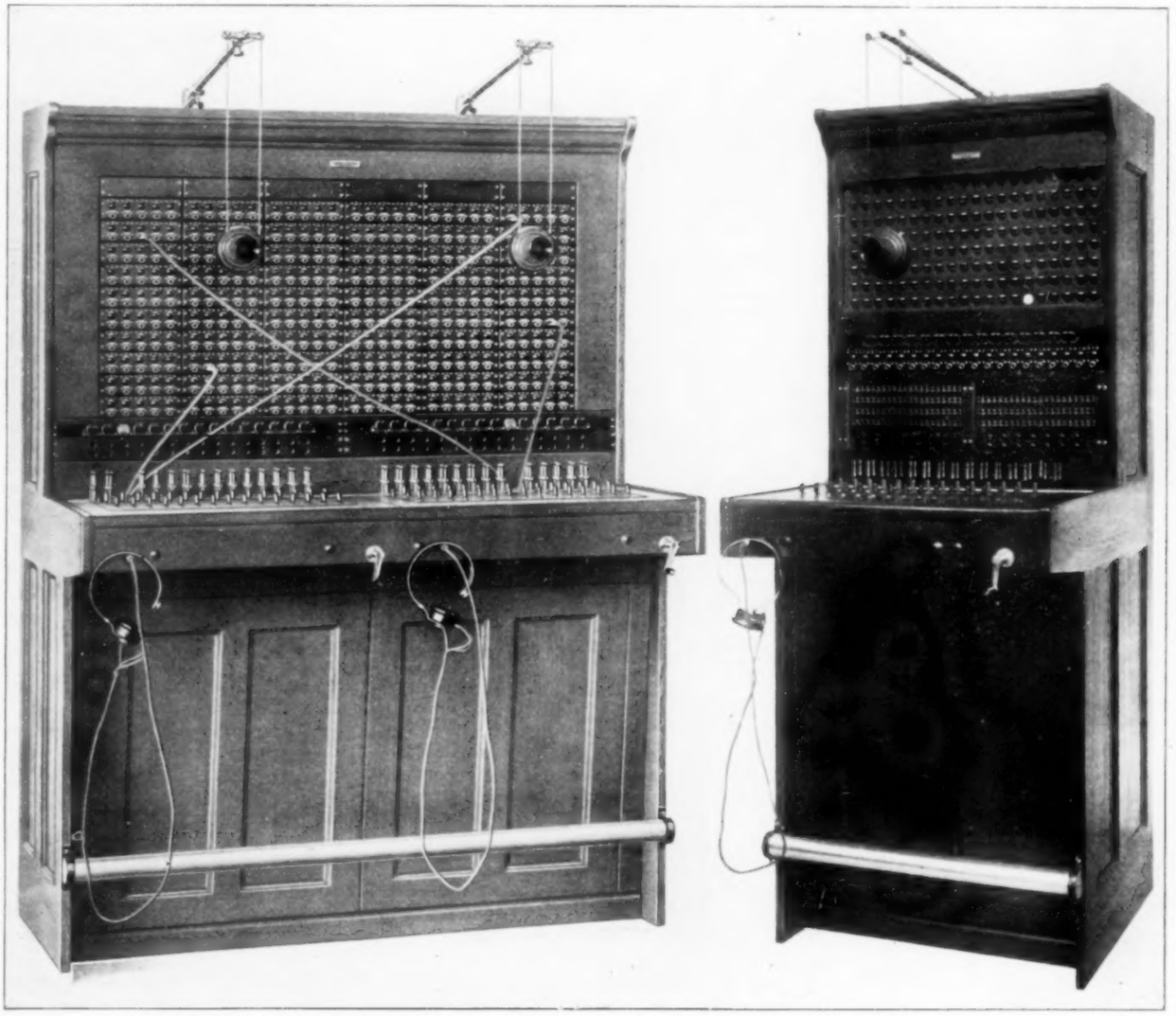


Fig. 1. Front View of No. 1250 Switchboard.

Fig. 2. Front View of No. 1245 Switchboard.

Each of these different sections is furnished with eight different types of equipment, as follows:

1. Magneto equipment, with self-restored line signals. (Code No. 2.)
2. Magneto equipment, with manually-restored line signal. (Code No. 4 for selective lines; Code No. 56 for bridging lines.)
3. Magneto equipment, with electrically-restored line signal. (Code No. 34.)
4. Magneto equipment, with electrically-restored line signal (Code No. 34), arranged for conversion to central-battery service.
5. Central-battery equipment, with magnetic line signal. (Code No. 34.)
6. Central-battery equipment, with lamp-line signal.
7. The magneto switchboards are arranged to be additionally equipped with ringers for operation on exceedingly long lines or on lines where audible code signaling is desired.
8. The central-battery switchboards are arranged to be additionally equipped with a No. 2 combined jack and signal for operation on rural lines.

All of these switchboards are furnished for operating with standard ringing systems, such as one-way, two-way, two-party, four-party pulsating, four-party harmonic, eight-party harmonic, etc. They are also furnished for single or double supervision. The double super-

vision cord-circuits used in these switchboards are guaranteed to prevent "ring-through" or "hang-up" difficulties.

When desired, these switchboards can be equipped with through toll line circuits (sometimes known as "cut-in stations"), audible code ringing on each of the line circuits, etc.

The Western Electric Company is offering in connection with these switchboards a standard line of accessories, such as lightning arrester cabinets, calculagraph sections, calculagraph shelf extensions, cash drawer shelf extensions, etc. It will be noted that this line of switchboards and accessories will fulfill every known telephone condition.

The general outline of these switchboard sections is such as to present a neat, practical and pleasing appearance. Fig. 1 illustrates a two-position section equipped with No. 2 combined jacks and signals.

Fig. 2 illustrates a one-position section arranged for magneto use, the line circuits in which are equipped with No. 34 signals for the city lines and a No. 2 combined jack and signal for the rural lines.

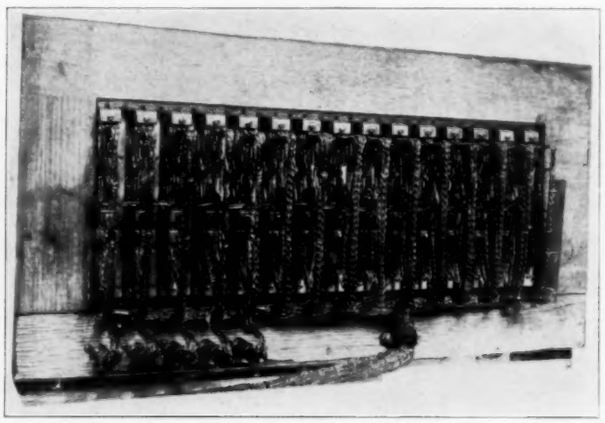


Fig. 3. Switchboard Keyshelf Open.

Some novel features of construction will be found in this section. All joints in the woodwork are tongued and grooved and securely fastened with a fine quality of glue and further reinforced with steel angles. The keyshelves of these sections are strengthened by steel bars to which the operator's keys are fastened by means of machine screws. This not only insures a perfect alignment for the keys, but permits of their easy removal should occasion require. The keyshelves are hinged by means of a piano hinge extending the full length of the keyshelf. This arrangement very materially strengthens the keyshelf and plug-shelf and also adds to the appearance of the switchboard. The exterior surface of the sections is finished with a rich, golden-oak finish. The outer coat of varnish is hand-rubbed and of such a character as not to scratch easily or to show ordinary wear.

The switchboards are equipped with Western Electric Company's Bell type of apparatus throughout. Many interesting features will be noted in connection with this apparatus. The No. 2 combined jack and signal used on the line circuits of the self-restored signal type of switchboard represents a radical departure from any previous design of magneto signal. The signal is given by means of an indestructible revolving steel ball, the visible portion of which changes color when operated. A portion of the surface of this ball projects out from the face-plate in such a manner that the signal can be seen from the side as well as from the front. One of the great advantages of this type of signal is that there are no projecting surfaces on the face of the board that are liable to injure the operator's hands or tear her clothes. Another novel feature of this signal is the circular armature that is made use of in order to permit of readily removing the coil from the signal. By means of the circular armature none of the line connections are disturbed in any way and no parts of the signal that enter into the adjustment of the same are disturbed. The coil is removed by the simple operation of removing a single screw. Especial attention has been given to the night-alarm attachment. This circuit is completed through two platinum-pointed springs that are attached to each of the signals, which springs make contact when the signal is operated. These springs are located in an accessible position behind the face-plate so that the operator can in no way injure them.

The No. 4 and the No. 56 type drops which are used in the manually-restored type of switchboards are of the standard "Bell" type, which has been manufactured for the last fifteen years.

The No. 34 signal used in the electrically-restored line signal type of switchboards both for magneto and central-battery operation has been thoroughly tried out in service. A total of about 1,900 switchboard sections in operation today are equipped with these signals. The keys that are used in these switchboards are of the well-known No. 102 type. They are equipped with horizontal springs that are mounted on edge in blocks of hard rubber. By means of this construction it is possible for the trouble-man upon opening the keyshelf to see clearly at a glance whether or not any trouble or obstruction is in the key springs. This feature is shown in Fig. 3. This renders it seldom necessary to remove the key from the keyshelf.

The cords used on all of these switchboards are of the flat steel wire type, which are renowned for their long service.

In the design of all of the apparatus used in these switchboards especial attention has been given to the high efficiency of operation and also to a low maintenance expense. Especial attention has also been given to the location of the apparatus in the switchboard sections. The result is that all of the apparatus is easily accessible and the services of an expert are not required in order to maintain these switchboards.

Harvard Electric Company Announcements

The Harvard Electric Company has adopted a new plan of insuring its securing prompt delivery of the materials and parts which go into the Harvard products. Commencing September, an expert will travel all over the country to call on firms from whom the Harvard Electric Company purchases, such as steel, screws, porcelain, carbon, brass and other manufacturers, and it will be his duty to see that adequate steps have been taken to give the Harvard Electric Company its supplies on schedule time. If there are any methods by which these can be hurried along, he will suggest them.

Allen Lee Haase, general sales manager of the company, is now on the Pacific coast combining business with pleasure.

The Harvard Electric Company announces that after September 1, 1909, its Chicago office and factory will be located at 523 West Van Buren street, where with greater quarters and more adequate facilities it will be better able

to take care of its rapidly increasing business. As before the Eastern office will remain located at 136 Liberty street, New York City, in charge of John J. Waldman, Eastern manager.

The company has just issued bulletin No. 18 relating to brackets, sectional switch boxes, conduit boxes, telephone fuses, wire joints, etc. In this bulletin there is given a detailed description of the various Harvard specialties, dimensions, etc. Harvard specialties are used by the Bell and larger independent telephone companies, electric light companies and electrical contractors.

Western Bell Consolidation

In a consolidation of all the Bell telephone interests in Iowa, Nebraska, Minnesota, North and South Dakota, the first step has been taken by centering the management of the five Bell companies operating in that territory in one man, Casper E. Yost, of the Iowa Telephone Company, with headquarters of the new combination at Omaha. This action also practically amounts to the ultimate elimination of the Western Telephone & Telegraph Company as a holding corporation. The companies over which Mr. Yost takes the complete management and which will be consolidated are the Iowa Telephone Company, with headquarters at Des Moines; the Nebraska Telephone Company, with headquarters at Omaha; the Northwestern Telephone Exchange Company, operating in Minnesota and both Dakotas, with headquarters in Minnesota; the Duluth Telephone Company, operating in Duluth and West Superior, and the Mesaba Telephone Company, operating in northern Minnesota.

A Big Cable Shipment

On Tuesday, June 8, the Western Electric Company shipped the first sections of submarine telephone cable designed to connect San Francisco with Oakland, by way of Goat Island, beneath the waters of San Francisco bay. The cable was 2⅞ inches in diameter, containing 69 pairs of telephone wire, 26 pairs of No. 13 B. & S. and 43 pairs of No. 19 B. & S. On the big reel the first section, 4,250 feet in length, weighed 26½ tons.

The truck on which this cable was hauled weighed about five tons, and sixteen horses dragged the heavy load. The wagon was built very low, with a clearance of only 8 inches between its lowest part and the ground. Guiding eight teams of horses through the streets of New York and around the narrow corners is an unusual sight as well as a difficult task, and many stared at the cavalcade as it made its way along Bethune street from West street to Eighth avenue, thence up to Twenty-seventh street and west to the river, where the freight dock of the Lehigh Valley Railroad is located.

The second consignment of 4,250 feet left the Western Electric Company's factory in the same manner two days later.

The first two sections of this cable, 8,500 feet altogether in length, are to extend from San Francisco to Goat Island. When the other two sections of 7,800 feet arrive, they are to be stretched from the island to Oakland Mole. On Goat Island, connection with land cable is to be made. The entire 16,300 feet of cable is one of the largest orders for paper-insulated submarine telephone cable ever placed. The cable is consigned to the Pacific Telephone and Telegraph Company.

A Sixteen-Team Cable Shipment.

Western Electric Railway Telephone Exhibit

An interesting feature of the convention of the Superintendents of Railway Telegraph, held in Detroit, Mich., from June 22 to 25, was the Western Electric Company's exhibit of train-dispatching telephones. These attracted much attention and won favorable comment as the systems were in actual operation and represented the latest development in telephone train-dispatching equipment.

Two types of selector equipment were shown; the Cummings-Wray standard, with a sender and four stations and the Gill in two types, namely, the individual call and the high-speed multiple call, one sender and four stations of each.

The attention of visitors at the exhibit was directed to the many styles of apparatus developed especially for railway use. This line included transmitters, receivers, desk stands, transmitter arms, head telephones, keys, loud-speaking receivers, portable sets, line poles, hand sets, foot switches, test panels, protectors, dry batteries, siding telephones, extension bells, and hand generators. Any of this equipment shown could be used with either the Gill or Cummings-Wray dispatching systems. Other pieces of equipment that were thought to be of general interest to railroad men, such as telegraph relays, emergency cable, cords, composite sets and howlers were also shown.

The exhibit of transmitter arms was of special interest, including several distinct types, each having special features. Those shown were the Van Akin, the W. E. Special, the Flexiphone, the No. 1020 and the No. 20 desk stand.

The convention days fell in the midst of the late June hot wave. Western Electric fans were placed in the company's exhibit booth and these rooms soon became popular. Similar fans were placed in the convention room and were much appreciated. The Western Electric Company also distributed trademark paper weights, which were unique in design.

Representing the company at the convention were Messrs. W. E. Harkness, R. F. Spaner and H. L. Burns of New York, and Messrs. C. L. Howk and J. H. Finley of Chicago.

Yellow Pine for Telephone Poles

A series of tests in preservative treatment have been made by the Forest Service on yellow pine for telephone poles. This tree has qualities which make it a desirable pole timber, but it is not durable, and decays at the butt in a few years when set without being given a preservative treatment. An experimental plant was operated near Fresno, Cal., in which about 600 poles were treated. It was found that the western yellow pine ranks among the woods which are most easily impregnated with preservatives, and that when thoroughly seasoned a penetration of from two to three inches was obtained by immersing the butts of the poles in a tank of hot creosote for a period of one hour, followed by five minutes' immersion in cold creosote. Owing to the ease with which it absorbs the preservative, western yellow pine is admirably adapted for treatment by the open-tank process. The treatments can be conducted with comparatively simple and inexpensive apparatus, and it seems likely that the pine pole with creosoted butt will replace the cedar pole in many localities when its advantages are more commonly recognized.

Western Telephone Manufacturing Company Moves

The Western Telephone Manufacturing Company, which has recently been reorganized and the name changed to the Western Telephone Construction Company, has been moved from Muskegon to Chicago, making the latter city its permanent headquarters. Heretofore the company maintained a local office in the Medinah Temple, but it is now occupying its new factory on Curtis street, just south of Randolph street, Chicago. The general office has been moved to the factory. The general management of the company is in charge of H. E. Anderson.

Changes on Kellogg Staff

The Kellogg Switchboard and Supply Company announces that J. C. Murray has been appointed district sales engineer for the states of Illinois, Indiana, Ohio, West Virginia, Kentucky and the southern territory.

F. C. King, of the Logansport Home Telephone Company, will continue Mr. Murray's excellent work in Indiana.

Both these gentlemen are well known telephone men of long experience, and the widening of their field of work will be of interest to Kellogg customers and to the trade generally.

New American Electric Fuse Catalogue

The American Electric Fuse Company has issued a perpetual catalogue of telephone specialties. The line of loose-leaf pages at present embraced in its cool-looking cover of tan linen paper treat of everything in the way of American specialties, from a hundred-word history of the company's growth to the latest in fuses, protectors, connectors, compounds, frames and automobile spark coils. The loose-leaf construction promises more literature to come, and readers of Telephone Engineer will do well to get on the mailing list.

The Hoyt Electrical Instrument Works has issued a booklet describing the Hoyt Triune Voltameter for direct current. The instrument, as the name implies, combines practically three instruments in one—a 10-volt coil for testing storage batteries and making other low voltage measurements; a 30-ampere coil for testing dry cells, and a 1½-ampere coil for testing coil units.

The T. M. Partridge Lumber Company, whose announcement appears in the advertising pages of Telephone Engineer, is a manufacturer and producer of telephone poles. With yards in Minnesota, Wisconsin, Ontario and Manitoba, the company is enabled to promise quick shipments anywhere. Prospective pole buyers will do well to get Partridge prices.

Telephone Engineer is indebted to the Leeds and Northrup Company for the cuts used in illustrating the paper on "Principles of Fault Location," which appears in this number. The company manufactures all forms of electrical testing apparatus.

An Interesting Pole Picture

A panoramic view of the immense cedar pole stock of the Kellogg Switchboard and Supply Company, at Escanaba, Mich., was recently obtained and is produced herewith, which is interesting because of the difficulty in obtaining satisfactory views of this kind of a subject where a wide area must be covered, and yet bringing out clearly the important details, showing quality of stock, manner of piling, handling, wagon and train loading. This pole yard is economically laid out for quick shipments and low prices.

Panoramic View of the Cedar Pole Stock of the Kellogg Switchboard and Supply Company at Escanaba, Michigan.

A Novel Telephone Receiver

Some experiments on the use of iron-cored apparatus—such as electromagnets, dynamo armatures, or transformers—as loud-speaking telephone receivers, are described by Herr E. Kosach in the *Electrotechnische Zeitschrift*. Not only closed iron circuits, but straight-core open-circuit electromagnets, such as are shown in Fig. 1, were found to give good speech reproduction.

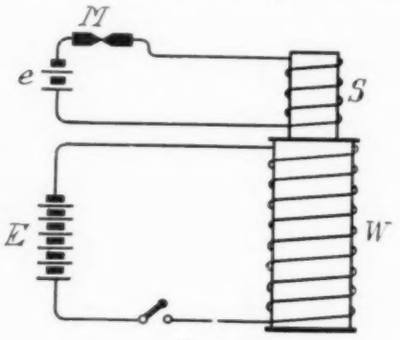


Fig. 1.

The soft-iron core, *K*, was initially magnetised by the winding, *W*, connected to the steady supply, *E*, whilst a second coil, *S*, also wound round the core, *K*, was connected in circuit with the microphone, *M*, and the cells, *e*. The reproduction is still audible when the magnetising coil, *W*, is omitted, although the effect is weaker. The effect can, however, be very decidedly improved if one end of the iron core is brought into contact with a fairly large plate, *P* (Fig. 2), of iron or other metal, or even wood.

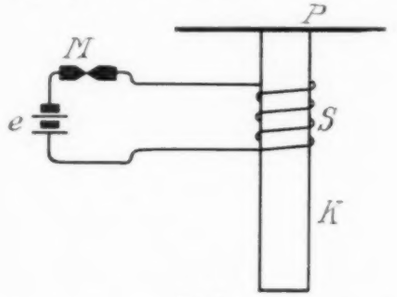


Fig. 2.

The best results were obtained with an iron-wire core, but solid iron or steel cores also acted.

It was also found that without any iron core the coil connected in the microphone circuit itself was capable of reproducing musical pieces, etc., with great purity, although only weakly, so that the coil had to be held close to the ear to become audible. A coil of iron wire gave somewhat better results than one of copper. Satisfactory results, for instance, were obtained with a coil of 30 or more turns of insulated wire about one millimeter in diameter, and wound on a diameter of five to ten centimeter. The effect is doubtless chiefly due to the electrodynamic action of the turns of the coil on one another, but it seems probable that molecular action within the wire also helps. It was found, for instance, that a coil embedded in a pitch-like mass, so as to be practically a solid block, acted no worse than an ordinary unembedded coil. The action could again be decidedly improved by adding a plate, *P* (Fig. 3), at one end of the coil. That the action of this plate is not of the same kind as that of the membrane of a Bell telephone is shown by the fact that quite thick plates can be used, and that the plate can be of any non-magnetic material just as well as of iron. The plate appears rather to act through the increased volume of air set in motion.

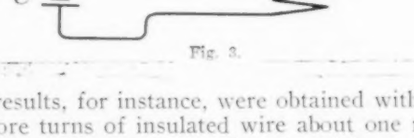


Fig. 3.

As a new form of receiver, the writer suggests the use of a brass bobbin wound with the microphone coil and provided with a metal plate at one end (Fig. 4),

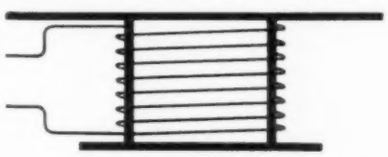


Fig. 4.

which might, perhaps, with advantage be shaped as a funnel. Such a receiver used with an ordinary granule microphone and connected to a few volts gives clear reproduction which is audible at considerable distances, whilst if the receiver is held to the ear the slightest whisper into the microphone is heard. The introduction of the usual induction coil between the microphone and the receiver does not interfere with the result. If the former on which the coil is wound is made of iron, very little improvement results. If the iron former is magnetised by a separate coil carrying a steady current, the result is again a little improved, and this improvement is found to occur even when no iron is present—*i. e.*, when the copper-wire coil connected to the microphone is surrounded by a second copper coil carrying a steady current in the same direction as the microphone current.

Telephone Securities Praised

Edward B. Smith & Co., New York, and Thomas A. Biddle & Co., Philadelphia, have published a pamphlet giving the results of their study of the plants of the American Telephone & Telegraph Company from the standpoint of an investment proposition. The pamphlet sets forth the many advantages possessed by the securities of this company, specifying that they are yielding an excellent return, with prospect of advancement; that the status of the business in the world is fixed; that the securities represent dollar for dollar in expenditure; that the business represents one that is universal in use, and that it suffered less than almost any other business during the time of depression, and that it has always a ready market value either for sale or as collateral.

Ohio Interconnection Injunction Dissolved

In a hearing to dissolve a temporary injunction restraining the United States (Independent) Telephone Company from interchanging business with the Central Union (Bell) Telephone Company, Judge Broderick made an order permitting the wires of the Bell company to be reconnected with the exchanges of the independent company.

Michigan Tax Commission Busy

Under authority granted by the state board of auditors, the Michigan state tax commission is enlarging its force for the purpose of determining the value of telephone properties of that state eligible to taxation by the ad valorem system under the new law.

M. A. Porter, of Northville, has been engaged as an expert, and others will be hired to appraise the value of the telephone properties of about 250 companies. This work must be completed by the first of next December in order that the tentative assessments may be made. The commission will use the valuation made by Professors Cooley and Adams in 1900 and revised in 1907 as a basis for the work and for the purpose of comparison.

Brevities of the Business.

PERSONAL NOTES.

Leigh S. Keith has joined the engineering force of McMeen & Miller, consulting telephone engineers, contractors and patent experts. Mr. Keith is a graduate of the Massachusetts Institute of Technology and has had vast experience in practical affairs. For several years he was employed on the general engineering staff of the New York Telephone Company. In the capacity of engineer in charge of central office installation, he was responsible for the equipment of some of the largest central office installations in the world; Broad, Cortlandt and Riverside exchanges serving as examples. Directly under the chief of the New York Telephone Company, he devoted much time to investigating the merits of automatic and semi-automatic equipment, and made exhaustive studies of traffic, plant and other phases of telephone maintenance and operation. For more than a year he devoted his entire time to a theoretical analysis of transmission, his research bringing him familiarity with all forms of transmitters and receivers. Since severing his connection with the New York Company he has been in many parts of the American continent investigating gas and electric light and power conditions for municipalities. Mr. Keith, as well as the firm who now engage his services, is to be congratulated. The relation should be pleasant and mutually advantageous.

C. P. Wainman, general manager of the Northwestern Telephone Company of Minnesota, North and South Dakota, will be the head of the commercial department of the functional reorganization of the central western Bell telephone companies, with headquarters at Minneapolis.

George A. Ullman, president of the Star Telephone Company, Wooster, Ohio, since its organization, has resigned, and Samuel H. Grabill, formerly vice-president, has been elected to fill his place.

R. H. Mathers has resigned as manager of the Union County Telephone Company, Richwood, Ohio.

W. B. T. Belt, formerly general manager of the Nebraska Telephone Company, has been appointed general plant superintendent for the Nebraska, Iowa, the Northwestern, the Duluth and the Mesaba Telephone companies, covering all the allied Bell companies in Nebraska, Iowa, Minnesota, North and South Dakota. S. S. Kelly, formerly superintendent of the Nebraska company, has been appointed assistant traffic superintendent of the above companies.

J. P. Baldwin, manager of the Benton Ridge Telephone Company, Benton Ridge, Ohio, has resigned his position, to take effect August 1, and will be succeeded by William H. George.

P. H. Coolidge, formerly manager of the Western Electric Company at San Francisco, also supervisor for the company on the Pacific coast, has accepted the position of assistant general manager of the Pacific Telephone & Telegraph Company, with headquarters at San Francisco.

A. B. Conklin, Elgin, Ill., has accepted the position of expert engineer and manager of the Atlanta Telephone & Telegraph Company, Atlanta, Ga.

A. E. Madden has been appointed manager of the Rocky Mountain Bell Telephone Company's exchanges at Cody and Meeteesee, Wyo.

H. D. McKinney, formerly of Janesville, Wis., has been appointed manager of the Clinton Telephone Company, Clinton, Wis.

Earl Roskar, formerly in charge of the Nebraska Telephone Company's exchange at Tekamah, Neb., will have charge of the company's plant at West Point, Neb.

The Cumberland Telephone & Telegraph Company has appointed J. S. Gillentine, of New Orleans, manager of its exchange at Jackson, Miss., to succeed A. W. Bennett, who has been transferred to the company's office at Nashville.

H. B. Marshall, for many years connected with the Chicago sales office of the Electric Storage Battery Company, has been appointed contract agent in charge of the company's office, Wainwright Building, St. Louis, Mo., to succeed Taliaferro Milton, who has been appointed engineer of the Chicago sales office.

George E. McFarland has been elected vice-president and general manager of the Nebraska Telephone Company, to succeed General Manager Belt, who becomes superintendent of plants under the new organization.

W. H. Patmore, for twenty years manager of the Nebraska Telephone Company's exchange at Beatrice, Neb., recently severed his connection with that company.

P. P. Black, who has been manager of the local exchange of the Home Telephone Company's plant at Hattiesburg, Miss., practically ever since its installation, has been appointed district manager for the company. He will be succeeded by J. S. Clark.

George Lyons, Waukegan, Ill., has been elected president of the Indian River Telephone Company, Fort Pierce, Fla.

Lon Lee has resigned his position as manager of the Home Telephone Company, Champaign, Ill.

NEW TELEPHONE COMPANIES.

Lake City, Ark.—The People's Telephone Company has been incorporated with a capital stock of $10,000; P. J. Springer, president; W. W. Perkins, secretary.

Napa, Cal.—The Imrieville Farmers' Telephone Company has been organized with the following officers: President, William G. Furber; vice-president and treasurer, F. W. Zettle.

Winchester, Cal.—The Winchester-Pleasant Valley Telephone Company has been incorporated, with M. L. Howell president and C. W. Patterson, secretary.

Molina, Col.—The Plateau Valley Telephone Company has been incorporated by K. G. Hill, John G. Hill and John H. Jensen with a capitalization of $50,000.

Jenkinsburg, Ga.—Application has been made for incorporation of the Jenkinsburg Telephone Company by B. F. Aiken, J. F. Tingle and others.

Bowden, Ga.—Articles of incorporation have been filed by a new company to take over the Bowden telephone exchange, now owned by B. W. Little, who will retain the controlling interest. Capital stock, $3,000. This step is taken to meet contemplated extensions.

Belleville, Ill.—The Hickory Grove Farmers' Telephone Company has been incorporated by Herman M. Eckert, Michael Muser, Henry Ahlers, Fred Deutschmann and Fred Hirth.

Eureka, Ill.—The Eureka Farmers' Telephone Company has been incorporated by C. J. Gibson, H. D. Schertz and A. L. Wood, with a capital stock of $5,000.

Worden, Ill.—Articles of incorporation have been filed for the Worden Telephone Company, with a capital stock of $2,500, by John C. Mueller, Charles W. Piper and F. W. Stocker.

Aldridge, Ill.—The Preston Union Telephone Company has been incorporated, with a capital stock of $2,500, by Dr. C. D. Gardner, of Grand Tower, and others.

Patoka, Ind.—The Patoka Telephone Company has been incorporated to construct and operate a telephone system in

Crawford and ajoining counties. The directors are: Jacob Patrenhenew, John T. Zimmerman, John Deitch, Thomas Smith, Ross Hamilton.

LOGANSPORT, IND.—The Toll Clearing Company has been incorporated by W. H. Uhl for the purpose of establishing and operating toll telephones; capital stock, $10,000.

EAST PLEASANT PLAINS, IOWA.—The Pleasant Plains Telephone Company has been incorporated, with a capital stock of $15,000, by O. C. Spaulding, J. J. Kyle, Mahlon Roberts, John Diers, and others.

CULLISON, KANS.—The Cullison Co-operative Telephone Company has been incorporated, with a capital stock of $7,000, by J. P. Chapman, I. N. Stonestreet and others.

REDFIELD, KANS.—Articles of incorporation have been filed for the Redfield Mutual Telephone Company with a capital stock of $5,000. The incorporators are: W. B. Lee, T. L. Dougherty and others.

NIOBRA, KANS.—The Hill Independent Telephone Company has been incorporated, with a capital stock of $10,000, by John Mayberry, Martin Knudson and others.

LILAC, KY.—The Leitchfield and Franks Mills Telephone Company has been incorporated, with a capital stock of $500, by Tramel Carter, J. W. Watson, J. C. Ramsey and J. C. Wilson.

MILO, ME.—The Milo Telephone Company has been incorporated by Frank W. Hamlin, president and treasurer, and others; capital stock, $5,000.

MOOSE LAKE, MINN.—The West Side Telephone Company has been organized. Bernard Nyhus is secretary of the company.

PRINCETON, MINN.—The Princeton Telephone Company has been organized by T. W. Thompson and others.

WELCOME, MINN.—The Welcome-Triumph Telephone Company has been incorporated. E. Hanley is manager of the company.

SANTIAGO, MINN.—The Santiago Telephone Company has been organized with the following officers: President, John Odegard; secretary, O. U. Vist; manager, John Knutson.

SPENCER BROOK, MINN.—The Spencer Brook Telephone Company has been organized with the following officers: President, T. T. Walker; secretary, A. Baxter; treasurer, Gilbert Clough.

CHINOOK, MONT.—The Co-operative Telephone Company has been incorporated with a capital stock of $40,000. The incorporators are: Rudolph Hermes, John Brummer, James N. Cook, W. D. Smotherman and R. L. Morris.

THOMPSON FALLS, MONT.—The Western Montana Telephone Company has been incorporated with a capital stock of $12,500 by A. S. Ainsworth and others.

KALISPELL, MONT.—The People's Home Telephone Company of Kalispell has been incorporated with a capital stock of $100,000. The incorporators are C. J. Bain and others.

OWEGO, N. Y.—Articles of incorporation have been filed for the Valley Road Telephone Company, capital stock $1,500. The directors are: Elias W. Truman, Dennis De Los Stanton and Lyman Witter.

GOLD HILL, N. C.—The Gold Hill Telephone Company has been incorporated; capital stock $50,000. The incorporators are: R. D. Coleman, A. B. Clennence and B. A. Fesperman.

JERSEY CITY, N. J.—The National Telephone Selector Company has been incorporated with a capital stock of $500,000. The incorporators are: Edward Kleinschmidt, Jerome A. Hughes, William C. Merriam Jr., all of 15 Exchange place, this city.

CLYDE, OHIO.—Harrison Baker and others have incorporated the Seneca County Mutual Telephone Company.

NEW BURLINGTON, OHIO.—The New Burlington Mutual Telephone Company has been incorporated by T. W. Conklin, A. V. Foland, John M. Hill and Walter Compton. Capital stock, $5,000.

FINDLAY, OHIO.—The Arcade Mutual Telephone Company has been incorporated by Sherman Huffman, Wm. H. Dilley, E. E. Bish, G. W. Dick, A. L. Anderson, E. T. Dailey and H. J. Harkness.

REMUS, OKLA.—The Remus Rural Telephone Company has been incorporated with a capital stock of $750 by J. A. Main, R. A. Harding, C. R. King, W. E. Varner, M. A. Warehurst, all of Maud, Okla.

HACKBERRY, OKLA.—The South Persimmon Telephone Company has been incorporated with a capital stock of $2,450. The directors of the company are as follows: Samuel Halley, Silas Phillips, E. J. Healey, G. L. Jones, E. P. Burdick, D. H. Keller, James Stewart and Sherman Johnson.

FARRY, OKLA.—The Anderson Creek Telephone Exchange has been organized by J. E. McMoran, R. I. DeGeer and Willis James, all of this place. Capital stock, $1,000.

READOUT, OKLA.—The Stockholm and Southwestern Telephone Company has been incorporated; capital stock, $2,000. The incorporators are as follows: J. W. Williams, H. W. Allen, H. P. Amo, G. L. Nesbitt and J. A. Anderson of Readout, and A. Gardner of Cupid.

ANADARKA, OKLA.—The Anadarka Southern Telephone Company has been incorporated by J. E. Stalder, E. S. Henry, Ed Newhouser and others.

TALALA, OKLA.—Articles of incorporation have been filed for the Talala Telephone Company by A. W. Campbell, J. L. Beatty, A. J. Rider, C. Graves, R. L. Farrer and A. O. Fisk. Capital stock, $5,000.

VINITA, OKLA.—The Craig County Telephone Company has been incorporated with principal offices in this place. Capital stock, $3,000. Incorporators: Mathew Fields and E. E. Leforce of Estelle.

GASTON, ORE.—The Hill Mutual Telephone Company has been incorporated by R. W. Airey, I. S. Ramsey, Charles Holt, C. J. Torstens, David Cruickshank, C. A. Wyman, J. Kopplin, O. G. Cornshan and I. M. Hill. Capital stock, $500.

HILLSBORO, ORE.—O. G. Wilkes, George Stevens and George Schulmerick have reorganized the Independent Telephone Company and have incorporated under the name of the Washington County Telephone Company, with a capital stock of $25,000.

INDEPENDENCE, PA.—The Independence Farmers' Mutual Telephone Company has been organized with the following officers: President, Dr. R. A. Stewart; vice-president, George W. Buxton; secretary, C. P. Buchanan; treasurer, Harry G. Huffman; directors, Clyde H. Perrin, James W. Murdock and U. U. Thompson.

CHAMBERSBURG, PA.—The Grindstone Hill Rural Telephone Company has been organized with the following officers: President, George M. Branthaver; secretary, Charles Branthaver; treasurer, John Hafer.

MOUNTAINVILLE, PA.—Articles of incorporation have been filed for the Mountainville Telephone Company by Charles H. Stoneback and Frank C. Newcomer, Coopersburg; Charles E. Erney, Frank Wagner, Israel Miller, John J. Weaver, Charles Schubert, Uriah Hildebeitel, M. A. Bitting, Salisbury, and George E. Carter, Emaus.

BUTLER, PA.—Application has been made for a charter for the Fenelton Telephone Company by W. I. Sipe, F. P. McBride and P. S. Fennell, Mr. McBride being president and Mr. Sipe secretary of the company. Capital stock, $10,000.

LE MOYNE, PA.—The West Shore Telephone Company, a subsidiary of the American Union Telephone Company has been incorporated by W. W. Zerby, S. K. Woodring and J. J. Bowers of Bellefontaine. The capital stock is $5,000 and the general office of the company will be in this city.

ASHERTON, PA.—The Asherton and Augustaville Telephone Company has been incorporated with a capital stock of $5,000.

PARKWOOD, PA.—Articles of incorporation have been filed for the Parkwood Farmers' Telephone Company, with a capital stock of $5,000.

LANCASTER, TENN.—The Lancaster Telephone Company has been incorporated by W. T. Simpson, Robt. Heflin, H. C. Lancaster Jr., J. D. Fisher, M. L. Trawick, J. F. Pritchard and Tom Betty. Capital stock, $2,500.

UNION CITY, TENN.—The Obion County Telephone Company has been organized. Among those interested are J. C. Burdick and W. R. Andrews.

STANTON, TENN.—A local telephone company has been organized with the following officers: President, W. B. Douglas; vice-president, W. S. McMahon; secretary-treasurer, F. G. Rawlins; business manager, P. O. Wilkerson. Capital stock, $2,000.

ALTAMOUNT, TENN.—The Citizens' Telephone Company has been incorporated. Capital stock, $4,000. The incorporators are: P. D. Hobbs, W. S. Cain, W. A. Hobbs and others.

TOYAH, TEXAS.—B. P. Vanhorn, A. G. Vanhorn and J. V. Gage have organized a telephone company, with a capital stock of $15,000.

WACO, TEXAS.—The Home Telephone Company has been incorporated to succeed the Texas Telephone Company. The officers of the company are: President, E. Rotan; vice-president and general manager, J. B. Earle; secretary and treasurer, M. H. Lane.

LINCOLN, UTAH.—The Progressive Telephone Company has been incorporated with a capital stock of $3,550. The officers of the company are as follows: President, J. W. Whitehouse; vice-president, Harriet W. Sagers; secretary, Charles Hansen; treasurer, Henry W. Droubay.

SPOKANE, WASH.—The Local and Long Distance Telephone Company has been organized with a capital stock of $100,000. The officers of the company are as follows: President, F. E. Woods, Coeur d'Alene, Idaho; vice-president and general manager, L. V. Gray; secretary and treasurer, R. C. Cushman.

Bremerton, Wash.—W. D. Calder of this place and C. J. Farmer of Port Townsend are interested in the organization of the Kitsap County Telephone Company, which has for its purpose the installation of exchanges in all the principal towns of the county, connecting them with the independent system at Seattle.

Sturgeon Bay, Wis.—The Peninsula Telephone Company has been incorporated with a capital stock of $5,000 by G. W. Greaves, John G. Walker and August Moeller.

Larsen, Wis.—The Larsen Telephone Company has been incorporated by Niels Jensen, A. H. Hindman and Louis Sorenson. Capital stock, $10,000.

Fordwich, Ont., Can.—The Springbank Telephone Company has been incorporated with the following directors: J. McLaughlin, R. Ferguson and J. Padfield. Capital stock, $10,000.

Toledo, Ont., Can.—The Rural Telephone Company of Kitley has been incorporated with a capital stock of $10,000. The provisional directors are: A. R. Hanton, J. M. Edgar and R. T. Beckett. The principal office of the company is in this place.

Iron Ridge, Wis.—The Town Hubbard Telephone Company has been organized in this place, with a capital stock of $2,000.

FINANCIAL ITEMS.

Colorado City, Colo.—The Texas and Pacific Telephone Company has increased its capital stock from $40,000 to $60,000.

Elliott, Ill.—The Dix Telephone Company contemplates increasing its capital stock to $25,000 for the purpose of installing an exchange at Gibson City.

Osborne, Kas.—The Osborne-Cheyenne Telephone Company will increase its capital stock from $4,000 to $7,000.

Saginaw, Mich.—The Valley Home Telephone Company contemplates increasing its capital stock to enable it to make desired extensions and improvements.

Columbia, Neb.—The Platte County Telephone Company has increased its capital stock from $40,000 to $100,000.

Bucyrus, Ohio.—The Bucyrus Telephone Company has increased its capital stock from $100,000 to $150,000.

Defiance, Ohio.—The Northwestern Telephone Company of this city has increased its capital stock from $60,000 to $100,000.

Manchester, N. H.—The Canterbury and Boscawen Telephone Company has increased its capital stock from $2,500 to $5,000.

Crosskill Mills, Pa.—The Bethel and Mt. Aetna Telephone Company has increased its capital stock from $10,000 to $25,000.

Newton, Wis.—The English Lake Telephone Company has increased its capital stock from $21,000 to $42,000.

Crandon, Wis.—The Crandon Telephone Company has increased its capital stock from $3,000 to $7,500.

FRANCHISES ASKED AND GRANTED.

Boothe, Ark.—The Boothe Telephone Company has been granted a franchise to install a telephone system in Mansfield.

Latham, Ill.—The Decatur Home Telephone Company has been granted a franchise to construct and maintain a telephone system in this place.

Bellville, Kas.—The Rydal Telephone Company has been granted a franchise to operate in this place.

Clinton, Mo.—The Missouri Union Telephone Company has been granted a franchise to operate in Clinton and Windsor.

Mandan, N. D.—The Southern Morton County Telephone Company has been granted a franchise to construct and operate a telephone system in the county.

Bellevernon, Pa.—A franchise has been granted the Independent Telephone Company to install and operate a system in this place.

Mazeppa, Minn.—The Goodhue County Telephone Company has secured a franchise to construct and operate a telephone system here.

MISCELLANEOUS.

Villanow, Ga.—The Sugar Valley Telephone Company has been purchased by M. Gordon Keown, president and general manager of the Armuchee Telephone Company.

Flagstaff, Ariz.—The Coconio National Forest Service will spend about $5,000 in the construction of a complete telephone system between its different ranger stations, which will connect with the Arizona Overland Telephone Company.

Dixon, Ill.—The Dixon Home Telephone Company is planning improvements in its system.

Decker, Ind.—The Wabash Home Telephone Company has been purchased by three local men and will be incorporated under the name of the White River Valley Telephone Company, with a capital stock of $10,000. The system was formerly owned by the Wabash Home Telephone Company of Monroe.

Hope, Ind.—The Hope Independent Telephone Company has been purchased by J. W. D. Aspey, Joseph Burney, Ardell Burney, Frank Tyner, A. J. McQueen and Gilbert J. Dennison, who will make extensive improvements and extensions.

Martinsville, Ind.—The Martinsville Telephone Company, of which C. S. Norton of Indianapolis is president, will install an up-to-date plant, a franchise having been granted for twenty-five years at an increased rate.

Bloomington, Ill.—The McLean County Telephone Company has been purchased by the Kinloch Telephone Company.

Joliet, Ill.—An effort is being made to have all telephone, telegraph and power wires operating in this city placed underground.

Chicago, Ill.—The Western Telephone Manufacturing Company has changed its name to the Western Telephone Construction Company.

Pleasant Plains, Iowa.—The Pleasant Plains Telephone Company has been purchased by a stock company.

Newton, Iowa.—The Boone County Telephone Company will install a new system.

Sloan, Iowa.—The Sloan Telephone Company has been purchased by W. R. Barnard, who contemplates overhauling the system.

Eldorado, Kas.—The Butler County Telephone Company contemplates placing its wires on Main street in cables.

Humboldt, Kas.—The Humboldt Telephone Exchange, formerly owned by C. Heim and Harry Kelly, has been purchased by F. M. Campbell for a consideration of $20,000.

Mt. Sterling, Ky.—The Old Kentucky Telephone Company will install a telephone system in this place at a cost of $15,000.

Monroe, Mich.—The Stoddard-Osgood Telephone Company has been reorganized under the name of the Home Telephone Company of Monroe. New capital will be secured for improvements.

Alpena, Mich.—The Alpena Mutual Benefit Telephone Company has purchased the Farmers' Mutual Telephone Company of Montmorenci County.

Rich Hill, Mo.—The Rich Hill-Butler Telephone Company is making arrangements to overhaul its entire system.

Kahoka, Mo.—The Kahoka Telephone and Construction Company will place its open wires in cables.

Butte, Mont.—The Independent Telephone Company will make many extensions during the coming year, including an exchange at Missoula, also at Hamilton.

Beatrice, Neb.—The Lincoln Telephone and Telegraph Company has purchased the Home Telephone Company's exchanges at Beatrice and Wymore.

Minneapolis, Minn.—The Northwestern Telephone Company will expend $1,000,000 in the territory which it covers within the next year.

Statesville, N. C.—The Iredell Telephone Company will erect a new exchange building in this place.

Albany, N. Y.—The Home Telephone Company is preparing to connect its lines with the lines of other independent companies throughout the East by laying two large submarine cables under the Hudson river.

Milford, Pa.—The Port Jervis Telephone Company expects to install an entirely new system with a capacity of 1,200.

Aberdeen, S. D.—The Dakota Central Telephone Company is planning to extend its lines west of the Missouri river.

Pierre, S. D.—The Great Western Telephone Company contemplates the extension of a line into Nebraska.

Hearne, Texas.—The local telephone system has been purchased by T. O. McGuire.

Pulaski City, Va.—The Virginia and Tennessee Telephone Company has changed its principal office from Pulaski City to Roanoke, Va.

Tacoma, Wash.—The headquarters of the Home Telephone Company of Puget Sound has been changed from Portland, Ore., to this city. The company is planning the expenditure of about $100,000 in improvements.

Victoria, B. C., Can.—The British Columbia Telephone Company will place its wires in this city underground. The project will be financed by the city.

Hanley, Sask., Can.—The Hanley Rural Telephone Company, recently organized, will construct about forty miles of line. D. M. Dilley is manager of the company.

Moosejaw, Sask., Can.—The Saskatchewan Telephone Company, with headquarters at this place, has been purchased by the government, for a consideration of $150,000. With a few exceptions, the government owns all the telephone systems in the province.